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A FACTOR IN THE PROGRESS OF PHYSICAL SCIENCE: A CALL FOR MORE IMAGINATION.

NEARLY everyone who has studied with any attention the history of progress in physical science, believes that advances come or not according as it is remembered or forgotten that knowledge is to be based upon experiment or mathematical deductions from experiment. There is nothing physical to be learned *à priori*. As Tait has observed, we have no right whatever, in view of the past experience of scientists, to endeavour to ascertain a single physical truth without seeking for it physically, unless it be a necessary consequence of, other truths already acquired by experiment, in which case mathematical reasoning is alone requisite. The history of the development of science provides innumerable illustrations of the consequences of neglecting this principle. At the same time certain schools of scientific thought have not yet quite cast off that tendency to so-called metaphysics which has often completely blasted the already promising career of a physical inquirer. The fallacy of basing physical results upon the old dog-Latin dogma, *causa æquat effectum*, frequently obtrudes itself; and it is difficult to decide whether the Latinity or the semi-obscure sense in this dogma is the more incorrect. The fate of Newton's successors ought ever to be a standing warning.

Metaphysical reasoning, in so far as it has any weight or validity whatever, is an unconscious appeal to experience. Oliver J. Lodge, in his well known lecture on "The Ether and its Functions," put this very clearly when he said that a person endeavours to find out whether a certain condition of things is by him conceivable, and if it is not conceivable he has some *primâ facie* ground for asserting that it probably does not exist. He has *some* ground, but whether it be much or little depends partly on the nature of the thing thought of, whether it be fairly simple or highly complex, and partly on the range of the man's own mental development whether his experience be wide or narrow. If a highly developed mind or set of minds find a doctrine about some comparatively simple or fundamental matter absolutely untenable, it is an evidence, and is accepted as good evidence, that the doctrine is one that is untrue; the argument being that if it were true it would have come within the range of experience. Nevertheless, there is nothing final about such an argument. All that the inconceivability of a thing really proves, or can prove, is that nothing like it has ever come within the thinker's experience; and this proves nothing as to the reality or non-reality of the thing, unless his experience of the same kind of things has been so extensive as to make it reasonably probable that if such a thing had existed, it would not have been so completely overlooked. The experience of a child, or a dog, on ordinary scientific phenomena, therefore, is worth next to nothing; and as their

experience is to ordinary science, so is the experience of the human race to some higher phenomena of which they at present know nothing, and against the existence of which it is perfectly futile and presumptuous to bring forward arguments because they are at present inconceivable.

If things physical are neither to be proved nor to be disproved by metaphysics, it would appear that the only course open to the serious investigator is the purely experimental one; and this is at the present day being pursued by most with a rigid adherence which would seem to suggest that the modern seeker after physical truths is afraid to trust himself beyond the well sounded shallows of ascertained facts. Here we venture to think is a source of danger to the immediate advantages of science, which, though less grave than that which beset the investigations of the old Grecian philosophers, appears, when all the circumstances of the present are taken into consideration, to be sufficiently serious. The science of electricity, perhaps, has not suffered yet in this way to the extent that the sister science, chemistry, has; but then it is younger—at least in point of achievement. The danger is no less present, however.

What then is the attitude which scientific investigators in general, and physicists in particular, should assume in approaching the study of the great unknown—that unknown which doubtless contains more secrets capable of being solved and applied to the benefit of mankind than have ever yet been yielded up to past explorers? We venture to submit that the time has arrived when a wise use of the imagination should accompany the patient experimental investigation, now so characteristic. In the treatises of Plutarch, we note that the ancients were satisfied with an insufficient examination into some of the phenomena of nature; they were afforded opportunity of exercising their imagination on such phenomena without being able to invent any of those ingenious machines which are the outcome of the modern method and which aid the investigation of nature. With the single exception of some of the striking truths found in the writings of Archimedes, together with some other of the geometricians and mechanicians of Alexandria, amongst whom Hiero is notable, we should be perplexed to find in their writings any statements which could properly be inscribed in modern treatises. The reason for the small progress which the ancients made in physics is to be found in the fact that, depending upon a false method and having no apparatus, they only studied it as metaphysics. Now, we are, comparatively speaking, well equipped with the most efficient means of investigation; but it would seem that we lack what our forerunners possessed too much of, namely, imagination.

Imagination is a wide word. It covers operations very various in kind, and well we know that its too free employment is calculated to obscure some of the most critical processes in the evolution of knowledge. *L'Imagination galope, le jugement ne va que le pas.* Nevertheless, "without imagination," says Godwin, "there can be no genuine ardour in any pursuit, or for any acquisition." And we must bear in mind that the first meaning of imagination is expressed also by conception, or the conceiving faculty whereby we realise what we have not seen. It is not to be scoffed at, as is too frequently done by pseudo-scientists, for the power of full concrete realisation is a high effort of the mind. In proceeding from the known to the unknown, it is capable, wisely used, of affording definite guidance. We are accustomed to look to America as a country in which the consummation of utility is being achieved—as the *locus* of the fullest development of the practical applications of the results of science. It is noteworthy, therefore, to remark that amongst American scientific men there is a greater tendency to the moderate employment of the imagination than in any other country. And, as illustrations of this, it is only necessary to point to the recent speculations of Elihu Thomson, Edwin J. Houston, and Nikola Tesla, on electricity.

When we have no definite knowledge we may be driven to speculation, and often scientific speculation points the way to further advances in our theories of physics. Speculation is the result of imagination, science of investigation; and whilst speculation is not science, as we know full well, science is often to be benefited by speculative ideas. For spiritualists, circle-squarers, seekers after the *perpetuum mobile*, believers in the flatness of the earth and in the non-rotation of the moon, and a thousand and one similar notions, we have nothing but contempt. They are the products of allowing imagination to run riot; some may be earnest—all are quack-like. Still we believe that a well-balanced imagination, temperately employed as an adjunct to scientific research, will give direction to enquiry, and when the direction is a proper one, the right men will always come forward. At the present moment we are not daring enough. We ought not to be content to observe, measure, and record, leaving the generalisations to rarer minds. It should be ours to conceive as well as to plod, and to ennoble our work with a lofty purpose, born of an imagination well controlled; and in no profession is this more called for than in electrical engineering.

INSULATING MATERIALS.

Those who recollect the first introduction of underground insulated wires for telegraphic purposes, in all probability hardly foresaw the chequered and varied course which systems of insulation have undergone. The use of lead-covered cables, which the inventors doubtless thought would be a permanent success, was but short lived, yet now, after a term of nearly half a century, the soundness of the system when properly carried out has been definitely proved. So, again, it has been with India-rubber, which, condemned as it has been again and again, has once more asserted its value, and this time, as in the case of lead cables, with certainty of success. It is perhaps a little strange that the all-important element of low inductive capacity, which was one very strong argument in favour of India-rubber, should have now practically ceased to exist, for rubber, although in the early days of submarine telegraphy it was materially in advance of gutta-percha, has for some years past ceased to hold the front place in this respect. Much has been said about the failure of gutta-percha supplies but "the end is not yet" apparently, though if the supply is really limited there is reason to believe that the end is likely to be hastened. The network of submarine cables is now a fairly complete one and the tendency in the future is likely to be, not so much a general extension of this network as an increase in its

efficiency; diminished cost for message work will be demanded and this can only be met by increased rapidity of working. That this is so is instanced by the fact that for the most recent type of Atlantic cables an exceptionally large core is being used, involving, of course, a correspondingly heavy weight of insulating material. Should, therefore, the adoption of large size cores become general the consumption of gutta-percha would be heavy, and its supply might run short, thus hastening the use of India-rubber, the supply of which, owing to the large number of the rubber trees, is not likely to fail. This however, assumes that fast speed transmission can only be obtained by the use of heavy cores; there is little as yet to indicate that fast speed can be obtained in any other way, it is so in the case of telephone transmission, although it has been affirmed that long-distance transmission is a matter of instruments not of the line. The affirmation has not been borne out by facts, for it has been found necessary to erect heavy trunk wires in order to get long-distance speaking. A great stimulus would, of course, be given to cheap ocean telegraphy if a considerable reduction could be effected in the cost of cable construction, but, as yet, there are no signs that anyone is inclined to risk money in making what might prove costly experiments, otherwise, the "light" cable which has so often been talked about, but which has never progressed beyond the sample stage, might have been tried on a large scale ere now. The adaptation of paper for cable core insulation is a dream of the future, but there seems no valid reason why it should not eventually be adopted, though there are many stumbling blocks in the way of its employment to be removed. It is a somewhat remarkable fact that so little progress has been made towards finding a cheap and efficient substitute for gutta-percha and India-rubber, though the records of the Patent Office of any early date show that the subject has by no means escaped attention.

Patent Agents.

There are two Bills just now under the consideration of Parliament, relating chiefly to the registration of patent agents. The constitution of this important body is always of great importance to the inventing public. The public expect legislation on this subject on the one hand to prevent incompetent persons acting as patent agents, and on the other hand to guard against the creation of a monopoly and its consequent exorbitant fees. In other professions, such as those of solicitors and dentists, these ends have been attained by giving a representative body in each profession the control over the admission of new members, by examination. This no doubt secures competence amongst the members, but if there is no control by an independent body over the examinations, it leaves in the hands of the profession the power of restricting its numbers and thus creating a monopoly. In the Bill which is being promoted by the Chartered Institute of Patent Agents, the Institute is to have the entire management and control of the examinations, and may alter the regulations at any time with respect to them. The other Bill, which is being promoted by the Society of Patent Agents, appears to be greatly to be preferred in this respect. Any person desiring to qualify for enrolment as a patent agent will be examined by the Council, unless the candidate is shown to be of evil repute, but such refusal can only be made with the sanction of the Board of Trade. The bye-laws regulating the preliminary qualifications for examination, and the constitution of the examining body have also to be submitted to and allowed by the Board of Trade. It is to be hoped that Parliament will not put into the hands of a profession, numbering only some 250 members, the power of creating a practical monopoly at the expense of the already heavily burdened inventor.

Frequency and Periodicity.

It is, perhaps, not remarkable to find that there are many who, from various causes, fail to correctly use the words periodicity and frequency. We are neither going to abuse nor defend the philological electrician who first let them loose in the jungle of electrical terms, we would rather attempt something of a definition. Frequency and periodicity are used to distinguish between single and double vibrations; a single vibration may be represented by $\smile$, a double vibration by $\sim$. The single vibration, or wave, is of the same sign throughout its duration, rising from zero and falling to zero, a series of such waves $\frown\frown\frown\frown$ form a unidirection pulsating current, and are produced by rectifying a single alternating current by a commutator driven by a synchronous motor, such current has a "frequency" equal to the number of waves per second. The double vibration consists of + and − waves following each other alternately, hence forming what is called an alternating current represented by drawing the + wave above the zero line $\frown$ and the negative wave below the zero line $\smile$, such a current has a "frequency" equal to the number of waves per second, and a "periodicity" equal to the number of double waves $\sim$ per second, that is, the "periodicity" is half the frequency. The words frequency and periodicity are taken from the science of the pendulum; a pendulum swings, say, from right to left and then from left to right, giving a double wave called a period, the period being the excursion of the pendulum from the one position and back to the same position, a to-and-fro swing; the frequency of the swings is counted by taking each swing separately. We must confess that we do not see the necessity for using both words; either one of them would suffice in treating alternating currents, but "frequency" could be used for both alternating and pulsating currents.

"Local couples."

At a recent meeting of the Paris Academy of Science a new line of research was described by Mons. J. Schürr, which has for its object the elucidation of that well-known difficulty which occurs in practice, which is too frequently dismissed with the remark, "Only a case of local couples." To state a difficulty is well, no doubt; it is the first step towards its solution to recognise it. But, unfortunately, practical men who lead busy commercial lives, have not very often the time to give to the clearing up of matters which, to them, are obscure in origin and troublesome in effect. The electromotive force of a battery is, as is well known, often modified to a very considerable extent by the formation of local couples due to metallic impurities in the electrodes. Mons. Schürr wants to discover whether it is not possible, if we cannot eliminate them, to make use of them? He thinks it may be feasible, by the aid of these couples, to obtain differences of potential variable at will and capable of compensating the variations in the electromotive force of the battery. His first paper merely appropriates this field of research to himself, and deals with a few experimental results which go some way towards indicating that in his hands the problem will be solved.

CHLORIDE OF LEAD BATTERY.

By E. ANDREOLI.

(*Continued from page* 508.)

WITHOUT going back further than 1882 to trace the genesis of the chloride of lead batteries, we find that F. Maxwell Lyte at that time described in the following manner the mode of construction of his accumulator. "Several of the insoluble or slightly soluble salts of lead (among which may more especially be cited the haloid lead salts, such as the chloride, &c.) are readily fusible and may be cast in moulds, and, if allowed to solidify, the cakes of lead salt thus formed may be reduced to the metallic state, if placed at the cathode of any suitable and sufficiently powerful electro-generator and immersed in a proper electrolytic fluid. A porous, more or less coherent mass of spongy metallic lead of any required size or form, and reduced to the condition of such spongy metal, may be thus produced, and plates or other suitably formed castings of fusible lead salts, having been made of any requisite thickness and form, and reduced to the condition of such spongy metal, are eminently suited for the electrodes of secondary batteries or accumulators of electric energy. When such plates of spongy lead are attached to the anode of an electric generator, another plate being attached to the cathode, and the whole is immersed in a suitable electrolytic solution (*e.g.*, dilute sulphuric acid) the anode plate becomes rapidly converted into a mass of lead binoxide, and far more speedily than the sheets of lead used in the Planté or other accumulators, the spongy lead presenting a larger extent of oxidisable surfaces."

Was it a discovery that chloride of lead may be fused, reduced, and used as an electrode? Certainly not.

Nevertheless, the fact is undeniable that the first chloride of lead secondary battery was made 12 years ago by Maxwell Lyte, whose only mistake was to criticise the lead supports of the Faure-Sellon-Volckmar batteries, because the contiguity of the peroxide of lead is liable to induce a discharge of its excess of oxygen into the subjacent metallic surfaces, the battery having in consequence, at rest, a tendency to exhaust itself and run down.

This drawback of local action has been in the world of electrical batteries the cause of many discussions and especially of numerous failures in the attempt made by many electricians to construct anodes free from any local action, *i.e.*, without lead supports.

Which is it preferable to have? an anode with supports which works imperfectly, or an anode without conductors, but which will not work?

Maxwell Lyte was probably the first electrician who made such a statement as, "I do away with any lead supports, substituting for them other inert and inoxidisable conducting surfaces." Had Maxwell Lyte, instead of repudiating these lead supports, cast on them his fused chloride of lead, he would have at once secured the splendid success which is won by the chloride of lead batteries as they are now constructed, *i.e.*, by combining fused chloride of lead with grids.

It is worth noting that before Maxwell Lyte, Messrs. Crompton, and D. G. FitzGerald had, in 1881, made electrodes for electro-chemical accumulators, in which it was desirable to increase as much as possible the surface of the electrodes, and to have a structure which permitted of large quantities of gas being occluded or retained at or near the surface.

The highly porous structure and surface of these electrodes were obtained by making the electrode of a mixture or alloy of lead and substances such as sodium, potassium, or zinc, or a compound alloy of lead with two of the above substances, capable of being extracted and removed by the action of water, acid or other chemical agents, or by electrolysis.

These alloys of lead and sodium were made by heating and fusing a mixture of litharge and carbonate of soda in a covered crucible and then by casting these alloys. Dr. Charles de Sainte Marie, later on, constructed a chloride of lead primary battery, which was transformed into a secondary battery, known in France and in this country as the Marchenay battery, and which is characterised by the mixture of fused chloride of lead with chloride of zinc, this latter being eliminated in the manner described, in 1882, by Marquis Tommasi, and also by R. E. B. Crompton and D. G. FitzGerald.

No real progress had, however, been made. Large slabs of this material were difficult to cast and to reduce, while it was almost impossible to peroxidise them, without their contracting, buckling, cracking and breaking. I made hundreds of such plates, not one of which satisfied me until I cast the chloride of lead on an ordinary E.P.S. grid.

A chloride of lead slab is a very bad conductor of the electric current. There is no *prise de courant* in such an anode. To obviate this inertia, I combined the active material with a good conductor which, by its ramification through the plate would collect the current at all the points of the chloride of lead mass on charging the electrode, and distribute it in the same manner on discharging it. I imagined the grid in the cells or interstices of which the pastilles of fused chloride of lead are held, and I am positive *nobody in this country or abroad is in a position to say that a chloride of lead electrode combined with a grid has ever been fused, cast, reduced and peroxidised before those I made in* 1886.

(*To be concluded.*)

CALCULATING MAGNET COILS.*

By C. H. BEDELL.

THE constant use of tables of copper wire, as published, has made us so familiar with them that it is possibly useless to suggest a change, even if that change is nothing more than an addition. To those, however, who make frequent use of the tables for calculations of field winding—and they are not few, but many—one more column is of great help, saving much time and rendering results more certain.

It is well known that a certain voltage at the terminals of a piece of wire of a given size will correspond to a definite number of ampère-feet, whether the piece be long or short, if the temperature remains the same. For example, 1,000 feet of No. 10 B. & S. wire has a resistance of about one ohm; if a potential of one volt be maintained at the terminals of that 1,000 feet, about one ampère will flow, giving a total of 1,000 ampère-feet. With 2,000 feet of the same wire, having one volt maintained at its terminals, only half the current will flow, as we have double the resistance, but we will again have a total of 1,000 ampère-feet. In the same way every wire has a definite number of ampère-feet per volt, and the ampère-feet of any wire for any voltage can be obtained by multiplying the ampère-feet per volt for that wire by the voltage used.

American gauge, B. & S. number.	Ampère-feet per volt.	American gauge, B. & S. number.	Ampère-feet per volt.
0000	20,383	19	120·6
000	16,166	20	98·40
00	12,819	21	78·03
0	10,172	22	61·91
1	8,062	23	49·07
2	6,394	24	38·92
3	5,070	25	30·86
4	4,021	26	24·47
5	3,189	27	19·41
6	2,529	28	15·39
7	2,005	29	12·21
8	1,590	30	9·681
9	1,261	31	7·857
10	1,000	32	6·088
11	793·2	33	4·829
12	629·0	34	3·828
13	498·8	35	3·036
14	386·0	36	2·408
15	321·0	37	1·909
16	248·8	38	1·514
17	197·45	39	1·201
18	156·	40	·9528

In calculations of the field of a machine, find the ampère-turns required, then the ampère-feet, knowing the average length of a turn. If this number of ampère-feet be divided by the voltage used, we obtain the ampère-feet per volt that the right size of wire will give. By referring to the above

* New York *Electrical World.*

table the nearest size of wire can immediately be obtained. The amount of that wire which must be used is, however, another consideration.

[The numbers in Mr. Bedell's table representing the ampère-feet per volt are evidently the same as those representing the number of feet per ohm, the values of which are given in many tables.—Ed. *Electrical World.*]

THREE-PHASE TRANSMISSION PLANT IN AMERICA.

The first important application of electrical power transmission to textile manufacture has just been installed at Taftville, Conn., by the General Electric Company, to whose courtesy we are indebted for the description, the power being transmitted from Baltic to Taftville, a distance of nearly 4½ miles. It is a typical transmission by three-phase currents, in which motors of the synchronous type are used, not only to operate one of the most interesting cotton mills in this country, but also the power station of the Norwich, Conn. Street Railway.

Mr. E. P. Taft, the progressive founder of the Taftville cotton industry, long ago recognised the value of the available water power at Baltic, on the Shetugket River, near to which stood a ruined mill destroyed by fire some years ago, and having secured the property with the water rights, determined to utilise the power as soon as a successful means could be discovered. When the General Electric Company announced a practical solution of the power transmission problem, Mr. Taft carefully investigated the system, and finally decided to adopt it for the operation of his cotton mills. As with all progressive men, he was compelled to run the gauntlet of considerable obloquy and scorn for trying to accomplish what others believed impossible, and he was by many set down as an illusionist. He had, however, the courage of his convictions, and his mills in full operation are a standing rebuke to the false prophets of his failure.

The Ponemah Mills are situated at Taftville, also on the Shetugket, and about three miles distant from Norwich.

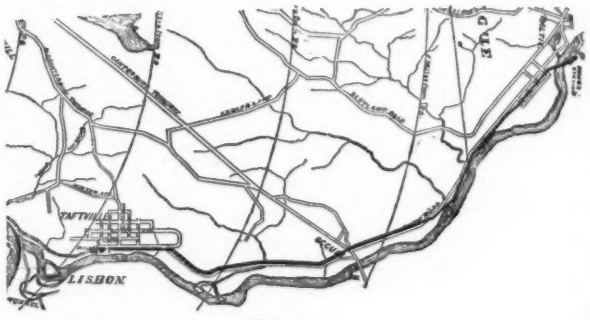


Fig. 1.

The original mill was operated for nearly a score of years by water power taken directly from the river, and when the new mill was erected it was found necessary to drive it from two 350 H.P. Corliss engines, the existing dam being insufficient in capacity. In these mills are manufactured perhaps the finest and most delicate cotton fabrics produced in America. All manner of fancy weaves for special purposes form the regular output of this mill, and the exceptional quality of the goods has kept the plant steadily at work during the dull times, even when cotton mills all over America have been shut down.

In fig. 1 are shown the relative positions of the generating station at Baltic and the receiving station at Taftville. The line is nearly 4½ miles in length, and is carried along the highway up the river, skirting its bank in places and crossing it at intervals to shorten its route.

In the basement of the rebuilt mill building are the wheel and dynamo rooms of the generating plant. The mill is of four stories, and built of stone. Four hundred feet above the mill a fine stone dam, 525 feet long, has been thrown across the river. The effective head on the turbines is 32 feet, and the water available, even in the dryest seasons, is sufficient to furnish not less than 1,500 H.P.

Fig. 2 is a plan of the basement of the mill in which the power plant is located. It will be seen that the turbines are belted to pulleys on the main line shaft extending the whole length of the wheel room and continuing through the partition walls into and along one side of the generator room. The pulleys are thrown into, or out of, action by Hunter clutches mounted with pulleys on quills, so that any or all of the wheels can be applied to drive the shafts. Similar pulleys and clutches are furnished in the dynamo rooms for throwing in or out the various machines that may there be placed.

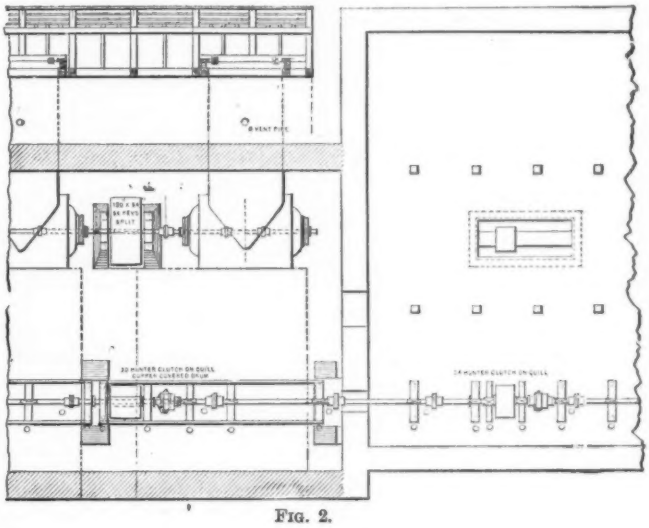


Fig. 2.

Fig. 3 shows the wheel-room, and the arrangement of the turbines and line shaft. There are three double 42-inch horizontal wheels, and one double 27-inch wheel, the former developing 800 effective horse-power each, at 157 revolutions per minute, and the latter 300 horse-power at 244 revolutions per minute. The belts pass obliquely upward to the pulleys on the line shaft, and the turbines are kept at speed by Schenck electric governors, which have proved themselves capable of doing very fair service. The wheel plant and shafting were made and installed by the P. C. Home Company, of Gardiner, Maine. The line shafting is supported by heavy iron girders set on stone piers, and additionally braced by timbers.

The dynamo room (fig. 4), beside the shafting, is occupied by two 250 kw. General Electric three-phase generators, delivering current to the line at 2,500 volts. Each machine is provided with its own exciter, a 3 kw. bipolar dynamo. The three-phase machines run at 600 revolutions per minute and are set so firmly on substantial foundations as to run with scarcely a perceptible vibration. The driving pulleys

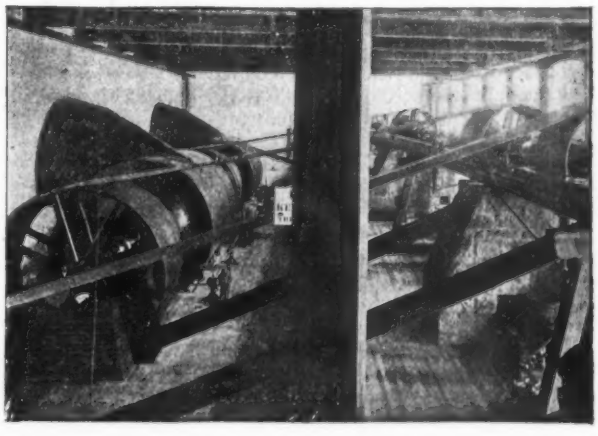


Fig. 3.

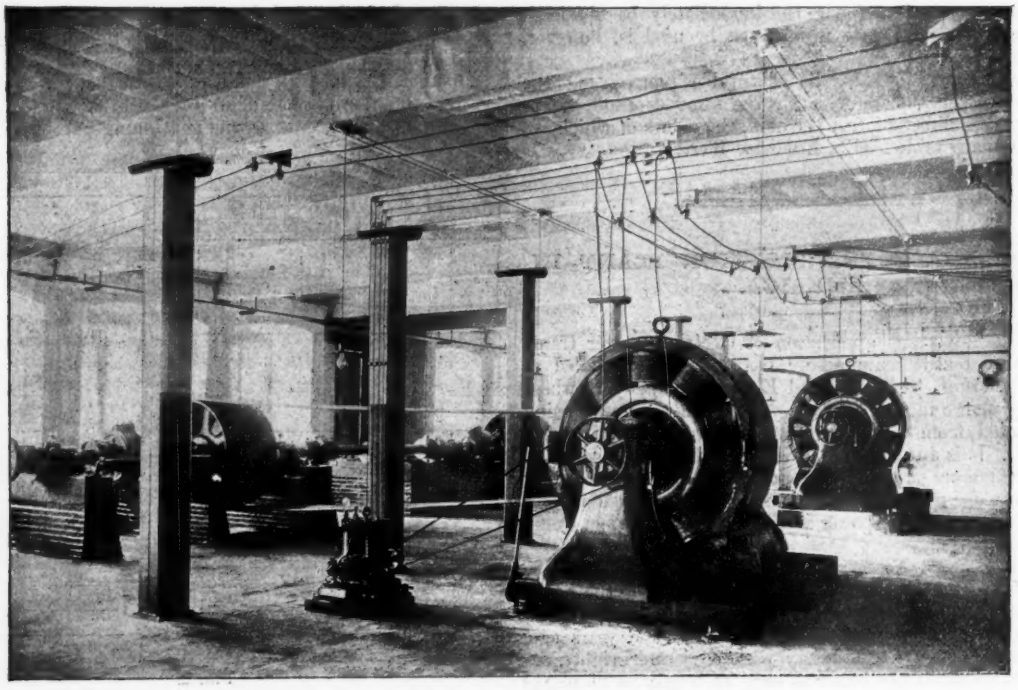


FIG. 4.

on the main shaft are fitted with Hunter clutches, so that either machine can be dropped out without the slightest disturbance to the service.

The generators are connected to a common switchboard, fig. 5, and may be run in parallel whenever desirable. To this end the board is furnished with synchronising apparatus, the acoustic synchroniser being mounted on the face of the switchboard, and the equalising switch being at the back. The most interesting novelties on this switchboard are the high voltage switches on the lower part of the board. These are mounted on marble bases, with substantial barriers erected between the switch-blades, so that the circuit at full load and voltage may be broken without the slightest danger of arcing across from point to point. They have been amply tested, and have proved their ability to cope with the trying work required of them with the greatest ease.

The generators fall into parallel easily, and run as smoothly together as would a couple of railway generators. No artificial load is used in throwing them together, none having proved necessary.

The line, a characteristic bit of which is shown in fig. 6, is a good piece of construction work on substantial wooden poles placed 100 feet apart. The upper wires on the cross arms are of 0 bare copper, and form the original three-phase circuit designed for the transmission. The wires on the lower cross arm are 0000 insulated wire, and are four in number. They were originally intended for a railway circuit, the generators for which were to be installed at Baltic to feed the Norwich Street Railway; but as the amount of copper necessary to do the work successfully appeared too great, the system was changed, a second three-phase generator and motor were added, and three of the four proposed feeder wires were utilised for the three-phase circuit. All are supported on the General Electric Company's standard oil insulator, the fourth 0000 wire forming a convenient relay in case of accident to any of the others.

At Taftville the three-phase circuits are led into the basement of the new mill, where they drive two three-phase synchronous self-starting motors, fig. 7, identical in size with the generators at Baltic. These machines replace the two Corliss engines previously used. One motor, with its switchboard, is shown in fig. 7, which also gives a view of the high voltage switch before referred to. These motors are belted to the jack shafting previously driven by the engine, the pulleys on the shaft being equipped with friction clutches so that the load can be thrown from engine to motor, or back again, without any interruption of service.

The motors start entirely unaided, coming up to synchronous

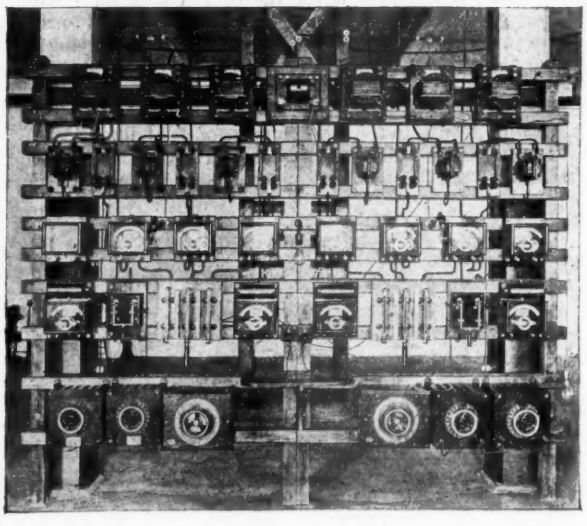


FIG. 5.

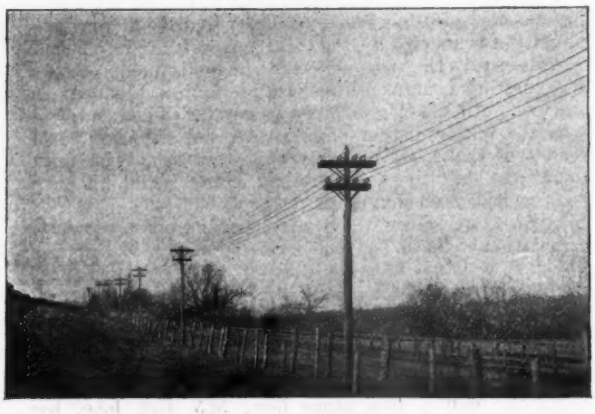


FIG. 6.

speed in about 50 seconds from the time the current is thrown on. They are, like the generators, separately excited, the exciters being driven from the pulleys on the end of the motor shaft.

The efficiency of the complete transmission at full load, from the power applied to the dynamo pulley to that delivered to the motor pulley, is just 80 per cent. In originally starting the mill before the second motor was ready for operation, it was the custom to bring the motor up to speed, and then gradually throw in the clutch connecting it to the shafting already running from one of the engines. When the clutch was fully in and engine and motor running together, the engine was disconnected by its clutch and the power transferred entirely to the motor. This could be done without producing the slightest disturbance in the speed, and in the same way, now that both motors are in and the engines shut down, the lead can be shifted from one motor to the other, if desirable. Ordinarily, however, there is work enough for both, when driving the 1,700 looms in the new mill, operating the lighting plant and the three 80 H.P. General Electric railway generators installed in another part of the basement.

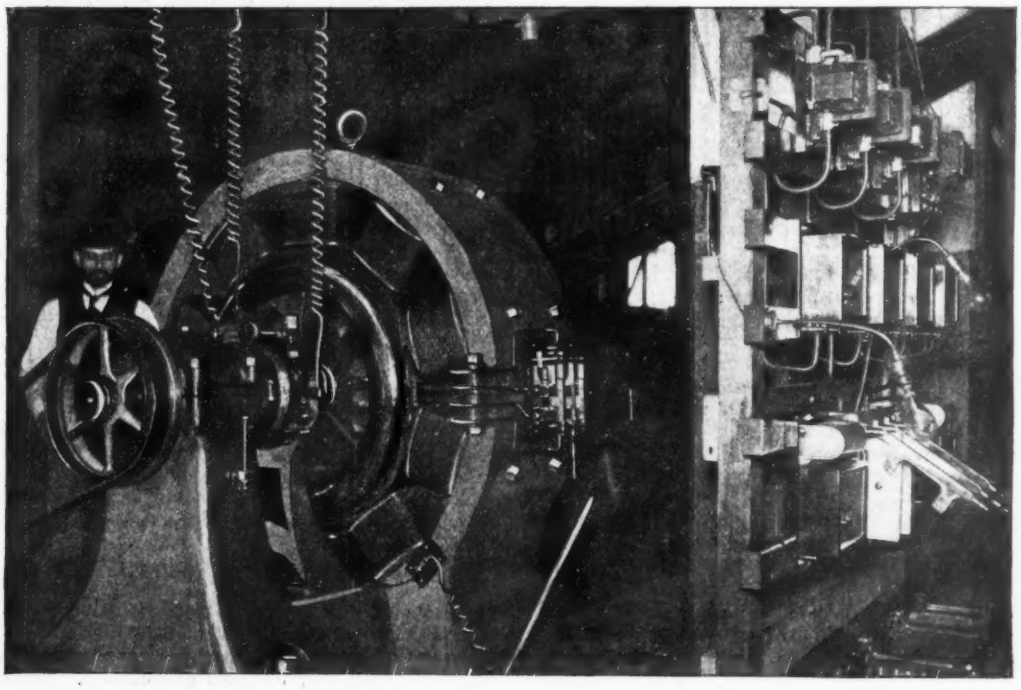


Fig. 7.

Fig. 8.

Fig. 8 shows the upper weave room of the new mill driven by these motors, and gives some idea of the work done by the motors and the extensive operations of the mill. This weave room is occupied at present in the production of delicate plain cotton goods for printing; the Jacquard looms for fancy goods being located on the floor below.

The first motor was started more than two months ago, and

the complete plant has now been in operation for several weeks, entirely displacing the steam service, and performing its duties in a highly satisfactory manner. It is already attracting great attention among cotton manufacturers, and Mr. Taft, whose far-sighted enterprise has put through this most important application of electrical power, is in constant receipt of letters of enquiry regarding its operation. These he is able to answer in the most encouraging terms.

THE INCANDESCENCE LAMP.*

By A. BAINVILLE.

(*Continued from page* 537.)

We will now proceed to the description of the manufacture of the incandescence lamp.

The modes of procedure adopted at the various works are nearly all based on the same principles; but the pains taken by manufacturers of lamps to keep their operations secret have, it must be observed, caused great diversity in the apparatus used to obtain the same result. The implements in use at each manufactory are consequently more or less imperfect, and, in all cases, can only be improved much more slowly than would be the case if each manufacturer contributed his stock of experience.

Nevertheless, during the last three years, considerable progress has been made both in the methods employed and in the implements used. This is due principally to the fall in the price of the lamp. More delicate and more carefully constructed tools, surer and more rapid processes have lessened the losses of manufacture, which at first were enormous, and considerably reduced the number of hands required. Now, when we consider that in this manufacture, the labour represents about half the cost of the article manufactured, we can form some idea of the importance of these improvements. In order to describe methodically the processes employed and the implements required for them, we will follow the order observed at the works, *i.e.*, we will discuss in turn the various operations and manipulations to which the lamp is subjected in the course of its manufacture.

The production of the incandescence lamp comprises:
The manufacture of the filament;
The manufacture of the bulb;
The preparation of the support;
The mounting of the filament on its support or wires;
The fastening of the filament to its support;
The carbonising of the filament;
Mounting the carbonised filament in the bulb;
The extraction of the air or making the vacuum;
The standardising of the lamp;
The socketing.

The Filament.

The filament of the lamp is, as we have already said, the conductor which, on being rendered incandescent, constitutes the source of light.

This function demands certain qualities, some of which are essential.

The most essential is certainly infusibility, or, at least, a very high point of fusion. It is evident that this quality is absolutely indispensable and that all substances not possessing it should be rejected at once.

Next comes electrical conductivity, which is only a subordinate quality with the means now at our disposal. However impracticable, in short, a lamp may appear to us at several thousand volts, such a lamp may, nevertheless, be constructed and maintained under certain special conditions which certainly do not come within the range of current practice at present, but which Tesla's splendid experiments, repeated in France with so much success by M. D'Arsonval, lead us to hope may one day be realised. Another quality of less importance, but one which should nevertheless be found in a good filament, is a high emissive power.

Lastly, the filament should fulfil certain conditions of molecular cohesion, homogeneousness, and elasticity, which are all essential.

Carbon, in which all these qualities are found, is now employed exclusively.

As regards infusibility, carbon certainly holds one of the first places. The point of fusion in certain metallic oxides might perhaps be sufficiently high for them to be rendered incandescent without melting; but it would be difficult on account of their very low conductivity to employ them alone, except for the high voltage lamps mentioned; if they are used in combination with carbon, besides the difficulty of obtaining homogeneous filaments, they are almost sure to waste; it is, in short, not very likely that metallic oxides will, at a high temperature, resist the combined consuming actions of the carbon and the electric current. If such filaments could be used, they would probably offer considerable advantages as regards the consumption of energy per luminous unit, especially if certain oxides are chosen which have the property of emitting at a high temperature certain special radiations in considerable quantities.

Practically, we cannot have with carbon lamps a higher voltage than 250 volts; indeed, at this voltage we meet with certain difficulties, such as the extreme fineness of the filaments, which prevents us having lamps of low luminous power, and other drawbacks which can only be avoided by using extreme care in the manufacture.

We have at last succeeded in making carbon with considerable density, *i.e.*, capable of offering a comparatively strong resistance to those molecular disturbances which the electric current provokes after a certain time (this time is almost proportional to the density of the carbon constituting the outer envelope of the filament). This carbon has greater rigidity than a metallic wire of the same section, which is an advantage, the atmosphere of the lamp being greatly rarefied and consequently exercising very little influence on the oscillations of the filament; it, however, offers a resistance to breakage quite comparable to that of a metal.

The filaments are all obtained by calcining at a high temperature substances containing carbon either in a free state or in a state of chemical combination. The manufacture of the filaments containing carbon in a free state is analogous to that of the carbons for arc lamps.

For this purpose we take some carbon as pure as possible, retort carbon for instance, which has been carefully washed and freed from all foreign substances. This coal is reduced to an impalpable powder, and by means of an agglomerant such as a liquid hydro-carburet, or a syrup made of sugar, a paste is formed which is drawn out under pressure. We can also, as in the Cruto process, obtain the carbon by the action of acids on saccharose. In this way we get a mixture of carbon and ulmic products. White sugar candy is also very well suited to this operation. The black precipitate which follows from the decomposition of the sugar, is washed carefully; but this washing is stopped when 2 or 3 degrees Baumé of acidity are attained. The paste is then dried, but in consequence of the little acidity retained in it, it does not dry altogether, but can be pounded and drawn out without the addition of any other agglomerant.

This process is very delicate. To obtain a perfectly homogeneous mass, we must reduce the carbon almost to the molecular state, and if we use an agglutinant, this substance generally produces on carbonisation a carbon different from that of which the mass is formed; the result is that it is very difficult to obtain homogeneity. Lastly, in order to give the filaments their shape, we must seize the moment when the paste comes out from the drawing-frame and is still soft; the drying, which necessarily causes contraction both in length and diameter, modifies this form more or less, or creates points where the molecular tension is greater. Consequently, the density varies more or less in the same filament, *i.e.*, its homogeneity varies, and, consequently, its specific resistance; moreover, the filaments are generally twisted, which produces a very bad effect in the lamp. Nevertheless, by using very high pressure, we can remedy some of these drawbacks. Moreover, M. Gerard has succeeded in obtaining excellent filaments by these methods.

The filaments manufactured from carbon, in a state of chemical combination, are the most extensively used. In nearly all, we start with cellulose, or we use parchmentised cotton (Swan process), or various solutions of cellulose in metallic salts, acids or ether, or lastly we use as a basis hydro-

* *L'Electricien.*

carburetted liquids resulting from cellulose being attacked by acids under the action of heat.

The parchmentising of cotton by the Swan process is the most simple mode of obtaining the filament. This process consists in immersing the cotton in an acid bath similar to that used for making parchmentised paper. This bath contains about three parts of sulphuric acid to one of water. When taken out of the bath, it is washed in water to remove all traces of the acid; and then, when dry, it is passed through drawing-frames, which first equalise it and then polish it, bringing it at the same time to the diameter required.

If we use dissolved cellulose for making the filament, the solution is passed through drawing-frames immersed in a liquid in which it is insoluble, water or alcohol, according to circumstances. The liquid vein is thus, on issuing from the drawing-frame, condensed into the form of a wire.

In some factories the filaments are cut out from plates of carburetted substances suited to the purpose required. All these filaments, however they have been obtained, must be carbonised at a high temperature.

The process of carbonisation is a very important one, and differs slightly, according to the origin of the filament. The filaments that received their shape at the moment they were made, such as those of which carbon is the basis and those cut out from plates, have not to undergo any preparation before they are put in the furnace. This is not the case with the filaments obtained under the form of wires (parchmentised cotton or drawn cellulose). The calcination itself is required to give these their definite shape. For this purpose the wires are wound on blocks, or moulds, of carbon of the form required.

If, after calcination, the filaments are to be U-shaped, the blocks of carbon will be of a shape analogous to that indicated by fig. 1. The transverse section of the mould shows exactly the shape that the filament will have after calcination (*b*, *a*, *e*, fig. 1).

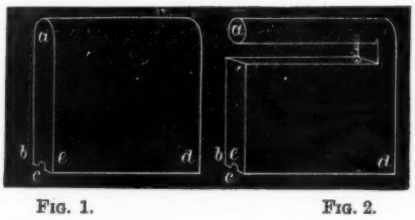


Fig. 1. Fig. 2.

The thread is wound round the block in the direction, *b*, *a*, *e*, *c*, *b*, regularly throughout its length. Care must be taken, however, to arrange the successive spirals so that they do not touch one another. When the mould is covered the extremities are fixed at the bottom at *b*, *c*, *d*, by means of any fastening that is capable of giving way before the filaments have experienced any contraction from the calcination, and before the block is put in the furnace the wires are cut along the groove, *c*. If this precaution were not taken the threads would break and we should run a considerable risk of all the filaments being spoilt. Calcination, which gives rise to chemical decomposition, produces a considerable contraction, amounting to about a third of the length and diameter.

If we wish to make the loop filaments, which are most commonly used now, the shape of the carbon blocks must be similar to that indicated in fig. 2.

The thread is wound as before, but each complete turn round the block includes a turn round the cylinder, *a*. If we wish to make filaments with a double twist, the thread is passed twice round the cylinder at each turn. When the mould is covered this thread is fastened at *d* *e*, as before, and cut along the groove, *c*, before being calcined. Care must be taken in this operation not to stretch the thread too tightly on the moulds, or too great tension would be produced in that part of it coiled round the cylinder, *a*, and we should get breakages after calcination. Various methods may, moreover, be employed to prevent this.

It will easily be understood that by varying the shape of the moulds we can obtain by similar processes filaments of any shape whatever. The blocks thus prepared are placed in crucibles. We can either lay them directly in pulverised carbon, or put them in cases, which are themselves placed in crucibles lined with charcoal dust. By the second method, which is, in some respects, the more costly of the two, there is less waste after calcination, as the movements of the thread during its contraction are not impeded.

If the filaments have been shaped before calcination, they have merely to be placed in little cardboard boxes, or even in a piece of cotton rag.

The furnaces in which are placed the graphite crucibles containing the filaments, may be constructed in various ways; but in all cases they must allow of very high temperatures being attained, and the crucibles must be constantly in a reducing atmosphere. For this purpose the crucible may either be placed in the fuel itself or on a hearth constructed for the purpose.

The furnace must be built of refractory bricks of very good quality, and solidly armoured, so as to resist the temperatures of 1,600 to 1,800° that have to be attained.

The calcination must be performed with great care; sudden variations of temperature must be avoided throughout the process, and above all, the highest temperature that can be obtained from the furnace must only be very gradually attained. When it is certain that this temperature is reached, the fire can be allowed to drop, care being taken to cut off the draught of the furnace and stop up all openings through which the air could penetrate to the crucibles. The cooling is thus effected very slowly.

The way in which the calcination is conducted varies according to the nature of the filaments used; thus, for example, the filaments obtained by drawing out a paste of carbon, require less care than those in which the calcination has to produce a chemical change. As we have already said, the crucibles in which the blocks or packets of filaments are placed, must be made of graphite of very good quality. Before using, they must be dried as thoroughly as possible. If this precaution is neglected, they soon become unfit for use, and an entire batch may be damaged or even wholly spoilt.

The furnaces, also, must not be used until they have been well dried. This is done by heating them very gently with a very feeble draught for some time after their construction; if this is neglected, they may be rendered unfit for use after the first operation. It is advisable not to commence a calcining operation until it has been ascertained that the furnace is in good condition and has been thoroughly cooled.

When the crucibles are cool enough to be held in the hand, they are drawn out of the furnaces, and the blocks or packets of filaments are removed with great care. These filaments, now transformed into carbon, have become very fragile, and require to be handled with great care.

The filaments that have been placed in cardboard boxes or wrapped in cotton rags, are easily withdrawn, and also the U-shaped filaments wound on blocks (fig. 1); but this is not the case with the looped filaments, and especially with those that are doubly coiled. The latter, although they are cut at the bottom, can only slip with difficulty over the cylindrical part of the block on which they are wound (see fig. 2); they must, therefore, be pushed along very gently. However, with a little practice, and if the winding has been carefully performed, very few are spoilt. If filaments of different diameters are placed in the same crucible, these diameters must be indicated by some mark; those of the same diameter must be put together before they are calcined: this constitutes the first sorting. The filaments must then be enclosed in boxes that are both air-tight and dust-tight, from which they must only be removed when about to be used.

(*To be continued.*)

THE EVOLUTION OF THE TYPEWRITER.

(*Continued from page* 537.)

Although the Hall typewriter was capable of competing, so far as speed was concerned, with the pen, it was not sufficiently portable in its earlier forms. The success which attended its introduction had the effect of drawing attention to the typewriter, which at this time—at the end of the sixties—was only awaiting the notice of commercial men to pass into the bands of manufacturers and become an article of commerce. Mr. Jenkins opened his second lecture with

a discussion of the causes which led to the remarkably rapid development of typewriters in the United States. This was largely attributable to the state in which that country found itself at the end of the disastrous Civil War. Enterprising men were looking round for suitable outlets for that energy which has distinguished manufacturers in America, and the condition of the labour market was one exceptionally favourable to the exploiting of a labour-saving machine, such as it was felt the typewriter could become. This led to the production of the first Remington machine in 1874, which was produced after only one year of experimental work. It is here necessary to depart somewhat from historical sequence, and to treat the practical forms of typewriters according to some definite classification based upon the method by which they work. Crowds of inventors have been at work, but the result has been that many types of printing apparatus have been re-invented long after their first appearance. The typewriter being a printing machine from which an impression of one letter is taken at a time, the first use found for it was copying of manuscript, and this still remains, perhaps, the most important work done by it. There are, therefore, two leading requirements which it must fulfil :—The finished work must be good, while the cost, the durability and the convenience in operating the machine decide the limits of its application.

Operators require that a machine should be perfect in alignment, be capable of manifolding, the writing should be visible at once, and ought to be correctly spaced, the line feed should be variable at will (that is, the spacing vertically should be narrow or wide at will), the feed should be given by one motion, the paper should be put into the carrier without any elaborate motion, and the carriage should take a large size of paper. The Remington keyboard is said to represent the best setting out of the keys so as to obtain a high rate of speed. In machines in which a single movement prints a letter, a very high rate of speed is obtainable. With a memorised sentence a speed of 120 words per minute, is said to be obtainable, but this is considered by expert operators to be a fearful speed. One hundred and ten is frequently obtained by those who are oblivious to external disturbances, but 90 is a high speed for even a good operator. One hundred and sixty has been obtained on a Hammond machine when the sentence "Now is the time for all good men to come to the aid of the party," was used, but such fancy figures cannot be taken as a basis for everyday work.

An even appearance in the written matter, which should be as clear as a piece of printing ; ready inspection during progress ; small movements to obtain an impression and these only of a simple and easy character ; the absence of any high degree of skill being necessary to obtain satisfactory results, that the mechanism should either act perfectly or not at all, and that the movements should act definitely, while the speed at which the machine could be operated should be greater than that ever attained at any time in use, are points more or less closely approached by many machines whose details were described. It is a pity that telegraphic machines should have been entirely excluded from mention in lectures dealing with "Typewriting machines," but the lecturer considered that they did not represent labour-saving machines, and were therefore outside of the scope of the true typewriter.

The Hall and Columbia are examples of the first class of machines, in which the type is held by a plate or is mounted on a type wheel. In this class the majority of printing telegraph instruments would fall. The second class comprises those typewriters which are fitted with type bars.

The question of size of keyboard, large or small, is a matter in which the opinion of operators generally has considerable importance. Manufacturers prefer a large keyboard, owing to the greater facility for adjustment and the ease with which large parts can be assembled. Unwieldy keyboards are objectionable, and machines with a small keyboard are compact. For example, if, say, the Caligraph had a keyboard half its present size the machine as a whole would be a compact one.

Machines in which the types are carried on wheels or plates include the Pratt, which was only made for experimental purposes, although it contained some valuable features ; the Crandall, which had a friction type wheel thrown on to the paper by depressing a key, and brought out five years before the Columbia, which employed a similar action, and others. Machines of this class were open to the objection of making an unpleasant noise, and there was a tendency for the change of case to involve great exactness in manipulation should a double case be used at all. The Hammond is a type-wheel machine, in which the change of case is effected by means of a vertical adjustment, the impression being taken by a hammer action, and the ink ribbon lies in a slit provided for the purpose. On this machine a speed of 160 words per minute has been obtained by the use of a memorised sentence. From actual experiment on a practical scale with the Remington machine, operated by a very fairly expert typist, we found that with the sentence "Now is the time for all good men to come to the aid of their party," 105 words per minute could be easily obtained, although when the sentence was "This is a specimen of the Remington type writer," only 88 words could be completed in the same time. From easy dictation with words averaging six letters, and with care in enunciation, 63 words per minute average could be maintained. In offices where female typists are employed to take down articles, &c., from dictation 6,000 words is considered to be a fair day's work. The sentence "The wily brown fox jumps over the lazy dog" is used to test the alignment of a machine, as it contains most of the letters of the alphabet, but it is useless as a speed test. The Munson machine is one also employing type wheels, and it is a pattern in which the characters can be readily altered at will by substituting different type wheels. In the Fitch machine an uninterrupted view of the writing is obtained, and the types are mounted in a swinging frame. There are certain mechanical objections to this, however, as the alignment is very easily thrown out.

The feed is an important point in a good typewriter. Pratt, in 1866, used a spring released by an escapement wheel, which was liberated on the pressing of a key, while in 1867 a weight was used to help the paper forward, while the feed proper was due to the key. One of the first attempts at variable spacing was the Crandall machine, which was arranged so that the dogs should slip two teeth on the rack when a wide letter was printed. Variable spacing is also a feature of the Maskelyne machine.

Mr. Jenkins closed his brief survey of the history of typewriting machines by condemning the use of oil for lubricating purposes as an abomination. He considered that as typewriting machines are more exact than most of the work done by machine tools within the limits fixed by Sir Joseph Whitworth, any lubrication should not be necessary. This may be so, but it is difficult to see how durability is to be obtained without its use, although operators, as a class, would welcome a machine in which lubrication was unnecessary.

THE NIAGARA TRANSMISSION SCHEME.

Commenting upon Messrs. Houston and Kennelly's article, which we reproduced last week, *Electricity* of New York says :—

"An estimate is given in the article of the distance to which Niagara water power can be economically transmitted by electricity. The authors come to the conclusion that on the basis of prices and voltages assumed and detailed, the power of Niagara Falls can be transmitted to a radius of 200 miles cheaper than it can be produced at any point within that range by steam engines of the most economical type. The assumptions on which their estimate is based are briefly as follows :—

"1. That the engineering difficulties can all be overcome by bare overhead tri-phase wires, at 35,350 volts receiving pressure, with step-up and step-down transformers at each end of the lines.

"2. That the plant be operated steadily 24 hours in every day.

"3. That the average load will be 60 per cent. of the maximum load.

"4. That coal costs $3 per ton.

"It is evident that unless these assumptions are absolutely correct the data based on these assumptions cannot be true.

"The first assumption of 35,350 volts receiving pressure is, to state it mildly, a very bold one, for the reason that there is no transmission system in practical operation employing such a high pressure. Electricians of the very highest

standing and connected with the largest manufacturing companies in the United States and abroad told us less than six months ago that for the present they would not recommend under any circumstances an initial pressure much over 10,000 volts. Whether or not such a high pressure, therefore, could be safely employed in practice is problematical, and at the present state of the art doubtful.

"As to the second and third assumptions we hardly believe that the average load will reach 60 per cent. of the maximum load. It must be taken into consideration that probably much more power will be used during the day than during the night; that the maximum will be reached during a few hours in the evening, and that the average load during 365 days of 24 hours will probably be nearer 30 per cent. of the maximum than 60 per cent.

"As to the fourth assumption, viz., the cost of coal to be $3 per ton, we think that with anthracite, pea, or slack coal, which can be obtained at about 75 cents a ton, and by the employment of efficient boilers and mechanical stokers, $1 worth of this coal would at least equal in heating property one ton of lump coal at $3. In the light of these considerations we think that the deductions of Houston and Kennelly should be taken with several lbs. (possibly tons) of allowance.

"We doubt very much indeed whether electric transmission from Niagara Falls beyond a thirty-miles radius can be made a commercial success at present.

"Following the general outline of Houston and Kennelly's paper, the operating expenses on '*our assumptions*' would be somewhat as follows:—

Syracuse, 164 *miles.*	
Annual cost at 30 per cent. full load per H.P. ...	$42.83
Buffalo, 15 (?) *miles.*	
Annual cost at 30 per cent. full load per H.P. ...	26.59
Cost of generating steam power per annum, with slack coal at 75 cents per ton, for 365 days of 20 hours (triple expansion compound engines), approximate	31.00

"These figures simply prove that anything can be proven when the basis of calculations is left to the assumption or guess of the computor. From our figures it would appear that even in Buffalo, at a distance of only 15 (?) miles, this electric power transmission scheme would not stand on a sound commercial basis, and, as a matter of fact, we have heard the opinion of many experienced men who doubt that electric power can be delivered in Buffalo at a profit.

"Dr. Walter Lobach, who was in charge of the work done by the Allgemeine Electricitats Gesellschaft on the Frankfort-Lauffen experiment, and who is now in Chicago, is our authority for the statement that the usual voltage in this experiment was not over 16,000, and was increased above this point only after the Exposition had closed for the day, and only for a brief time; and, moreover, that the efficiency from dynamo shaft to point of distribution at *full load* was about 75 per cent.

"This means, as will be apparent, at average load commercially an efficiency of about 45 per cent., having still to take into account losses in actual distribution and in motors, &c. This 75 per cent. represents efficiency at step down transformer in Frankfort.

"We do not make these statements to scare prospective investors in water powers, but we do believe it the duty of the electrical press to state the truth and facts and not to mislead the public by ambiguous reports and figures such as those presented by Houston and Kennelly."

DESCRIPTION OF THE ELECTRICAL TYPE-PRINTERS AS USED BY THE EXCHANGE TELEGRAPH COMPANY.*

By F. DIGBY LATIMER.

The Exchange Telegraph Company hold an unique position in the electrical world, inasmuch as they are the only users of type-printing instruments worked and regulated by means of electricity on anything approaching a large scale in Europe; in fact it may be said that the Higgins and Hughes patents practically hold the monopoly for this work. With regard to the Hughes printer it is principally mechanical, whereas the Higgins instruments are controlled entirely by electricity.

Bearing this in mind, I feel that a description of the method of working the Exchange Company's instruments, *i.e.*, those of which Mr. Higgins is the inventor, will be of interest to this meeting.

I have intended that this paper shall not be a theoretical one, thinking that by so doing it will be more welcome to you. I trust I shall be able to make myself understood; the mechanism of the various movements are, I need hardly say, rather difficult to explain, therefore I would ask that you will not criticise my paper too severely, and, in the event of any point not being intelligible, I shall be happy to explain it further by showing you the parts on the instrument I have working here.

Let us take the transmitter first. In general appearance it resembles a typewriter, in having a key-board, on which are engraved the letters and figures which will be recorded on the receiving instrument on depressing any particular key, K, K¹, &c.; they are arranged in the same way as the black and white keys of a piano. The inner extremity of each key falls beneath a little spring catch shown in the diagram marked C. At the back of the key-board is an electro-motor which drives a commutator, A, and an axle, B. On the axle are fixed a series of pins, P, P, &c., one to each key arranged spirally, the axle running the whole length of the transmitter.

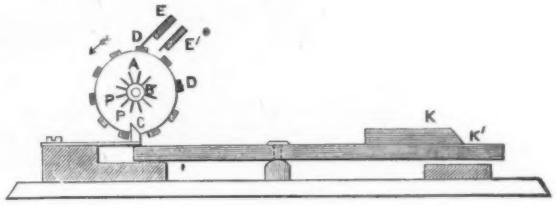


Fig. 1.

While the motor is driving this round, let us press the key, K: the axle continues to travel until the pin, P, corresponding to this particular key comes into contact with the catch, C, in which position it is impossible for it to move till you release the key, and consequently lower the catch, C, bringing it out of range of the pins, P, P, &c. Now, the commutator, A, comes into play. It is a circular disc of brass with a number of teeth, D, D, &c.; as a matter of fact it has half as many teeth as there are keys. As the commutator which is in contact with the line wire rotates, these teeth pass alternately under two brushes, E, E¹, constructed of German silver, which are connected to the two poles of a battery, the centre cell of which is joined to earth (fig. 2). These brushes are so arranged that when one is just beginning to press on a tooth, the other is just leaving the one behind it; in this way it will be seen that the two brushes are never both in contact with the commutator, otherwise the battery would periodically be placed on short circuit.

You will now see by the description and the following diagram (fig. 2) that alternating currents are sent to line, the number of alternations being directly proportional to the speed at which the commutator revolves.

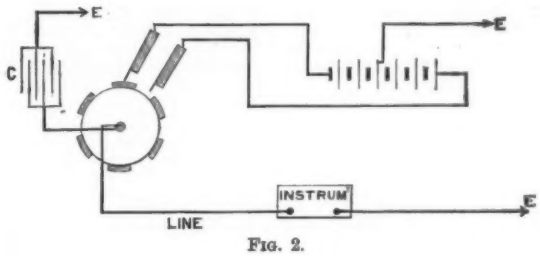


Fig. 2.

The average speed is 100 revolutions per minute, which, with the 18 teeth on the commutator causes a current of 3,600 changes of direction per minute, or 1,800 complete periods. In other words each current lasts for ·016 of a second, or about $\frac{1}{60}$nd part of one second. With currents of such short duration it will be readily understood that all electro-magnets to be used in the receiving instruments must have as little self-induction as possible, in order that their time-constants may be low.

I have said that when a key is pressed, the axle ceases to revolve, consequently the motor would be pulled up; this would not do, as you would have your motor battery on almost short-circuit, with the exception of the small resistance of the field magnets of the motor; in order to obviate this, an ingenious arrangement is used by which a catch is released upon a key being pressed, which, so to speak cuts out the axle and commutator, and leaves the motor free to travel until you release the key, when the catch falls and allows the axle and commutator to rotate; the motor, in fact, never stops while a message is being sent.

Switches are provided for turning on and shutting off the current for working the motor, also for the line currents. The motor used is of an ordinary kind requiring about eight double-fluid bichromate cells, I have five accumulators working the transmitter on the table.

* Paper read before a Students' Meeting of the Institution of Electrical Engineers on May 4th, 1894.

A governor is used for varying the speed, by which the current is automatically cut off and put on, the length of the breaks being varied by the adjustment of two little weights on the arms of the governor. The rotating portion of the transmitter is driven from the motor by means of cogged wheels.

When working direct from the transmitter, as in fig. 2, to prevent sparking on breaking the circuit between the brushes and the commutator, a condenser, C (with a capacity of $\frac{1}{3}$rd microfarad), is placed there which receives the high discharge consequent upon having so many electro-magnets in circuit; the brushes are also placed at rather a sharp angle, so that you have a very quick break.

An operator working such a transmitter as described, is able to actuate an unlimited number of instruments on any number of lines; in fact, we have one actually being used continually for eight hours a day which works 700 receivers scattered all over London without any attention being given to them.

As the commutator, A, revolves, the relays, R and R^1, are alternately energised from the local battery, B^1, thereby closing their contacts between terminals marked T and T^1, which causes a current first from one side of the battery, B, and then the other, to flow to line.

Fuses, F and F^1, are placed in circuit in case of an earth fault or contact.

Half an ampère is allowed to flow through the circuit, and works the instruments to the best advantage. The current is brought to the correct strength by means of resistances shown in fig. 3, and marked G and G^1.

Terminals are fixed in the office, H and H^1, for testing and localising faults.

The distribution of current is by means of what is known as the "Universal battery" system as employed at the G.P.O., *i.e.*, the same battery supplying current for all circuits.

Where there are a large number of circuits, the relays are joined in

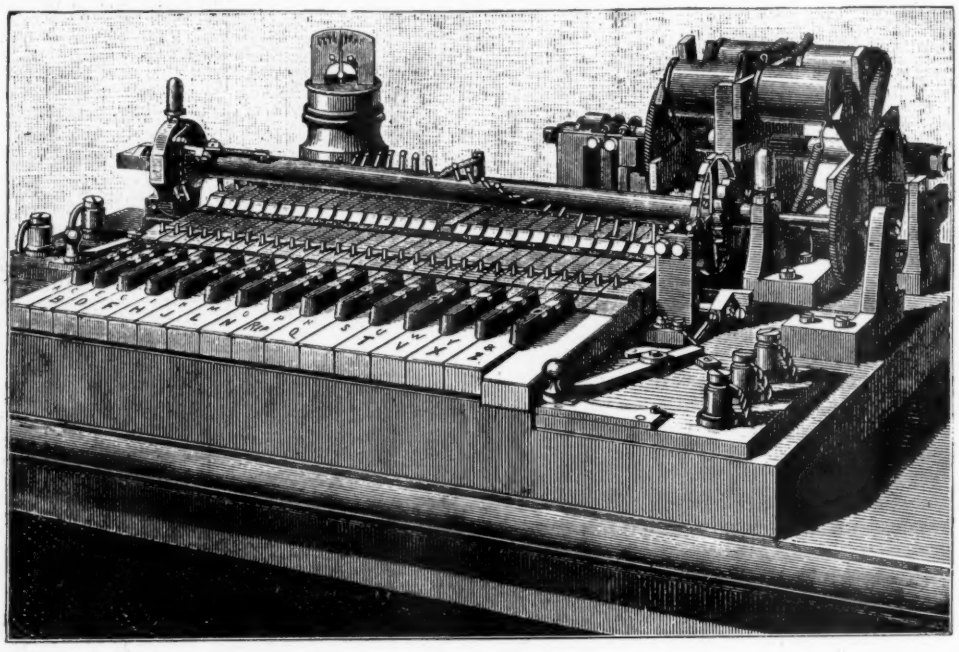


Fig. 4.—Transmitter of the Exchange Company's Apparatus.

LOUIS $9\frac{3}{8}$ ▪ $\frac{5}{8}$ DENV $10\frac{5}{8}$ ▪ $\frac{7}{8}$ PREF 2 ▪ $\frac{1}{2}$ CENT PAC $14\frac{5}{8}$ ▪ $\frac{7}{8}$

Fig. 5.

It is possible to work direct from the transmitter (the connections are shown in fig. 2), but where there are a large number of circuits it is found advisable to use relays and a local battery (the connections are shown in fig. 3); three relays, R, R^1, and R^2, are used to each circuit;

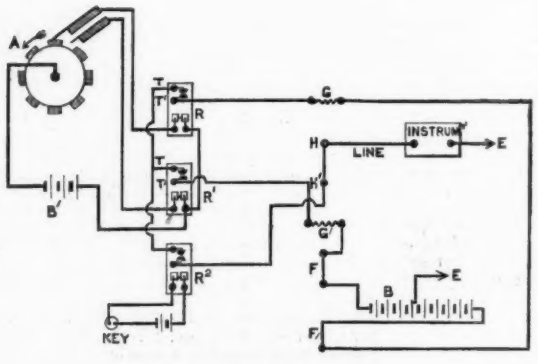


Fig. 3.

R and R^1 for sending the alternating currents from the main battery, B, and R^2 is a "repeat relay," the function of which I will explain later. This latter relay is worked by a key on the transmitter which, upon being pressed, closes a circuit of one or two cells through the coils of the relays.

series, and a condenser placed across the two end terminals to suppress sparking.

A general view of a transmitter is shown in fig. 4.

Having dealt with this transmitting apparatus we will turn our attention to the recording instruments.

There are several different types of receivers in connection with the various services which may for the purpose of facilitating explanation be divided as follows:—

(1). "The financial" service which records on the subscribers' instruments some 1,500 prices daily of stocks and shares.

(2). "The general news" which supplies news of general interest.

(3). "The column printer," a service which prints general news in column form.

In explaining I will deal with the receiving instruments in the same order as I have classified them.

(1) *Financial Recorders.*—A specimen of the printing of this class of instrument is shown in fig. 5.

Being of rather older design than the other receivers, they possess disadvantages which are not found in the newer forms, viz.: They do not record at such a speed as attained by the General News or Column printer; also they require two distinct circuits, therefore twice as much wire, which, of course, almost doubles the expense of fixing and maintaining. I have said that these instruments receive the prices of stocks and shares, therefore it will be seen that they require a larger number of figures than an ordinary service, the nature of their work necessitating a complete list of fractions.

To economise space these are arranged on two type-wheels fixed on the same axle, one having letters and the other figures; either of these can be brought into play by the pressing of a certain key by the operator (see fig. 9).

There are two distinct movements in all these instruments necessary to effect working, viz.:—

(1.) To get the type-wheel into the correct position.

(2.) To print the letter on paper.

In the "Financial" transmitter, and this is the only one which does not do so, alternating currents are not sent to line but pulsating

continuous currents. This is effected by only having one brush on the commutator, which continually makes and breaks.

On arriving at the receiving instrument these pulsating currents energise an electro-magnet, A (fig. 6). An armature, B, responds to the currents and is therefore kept oscillating first by the magnet and then by the spring, S, it being pivoted at D.

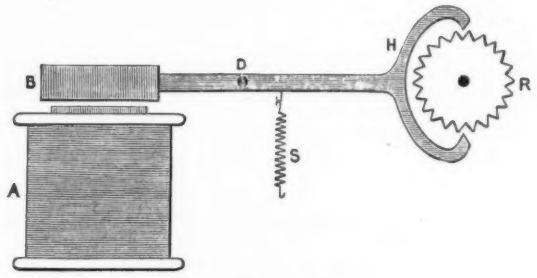


Fig. 6.

Attached to the armature is a forked lever, H, the forks of which engage with a ratchet wheel, R, fixed on the same axle as the type-wheel. As the armature vibrates it drives the ratchet wheel and type round.

In this way perfect synchronism of every type-wheel on all instruments is secured.

Suppose the operator has a message to send, he turns his transmitter on, every type-wheel commences to revolve and continues to do so until he presses a key, which, as it stops the commutator, must necessarily stop the pulsating currents, they in turn stop the type-wheel, and the correct letter or figure is in position for printing.

A general view of one of the "Financial Recorders" is shown in fig. 8.

(2) *General News Recorder.*—A specimen of the tape of these receivers is shown in fig. 9.

Fig. 8.

THE SOUTHAMPTON MAGISTRATES TODAY REMANDED STEPH

Fig. 9.

11•35•ARCHIBALD MACRAE ACCOUNTANT
GLASGOW WAS REMITTED TO THE SHERIFFS
COURT AT GLASGOW TODAY CHARGED WITH
EMBEZZLING L600 OF TRUST MONEY•
HE WAS ARRESTED ON BOARDING THE
-MAJESTIC- AT QUEENSTOWN•

Fig. 12.

This is now easily accomplished. An electro-magnet, A (fig. 7), on another circuit is so placed that when its armature, B, is attracted, it causes a pivoted lever, C, which carries the paper to come into contact with the type-wheel, D, thereby securing an impression of the type in position, when the current ceases the armature falls back from

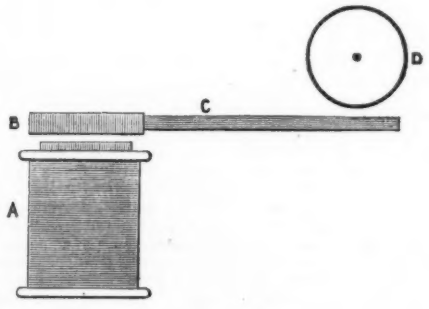


Fig. 7.

the type-wheel. The current for this magnet is automatically switched on every time the transmitter is stopped, and off when allowed to continue.

The paper is caused to be moved forward in order to obtain a clear space for printing by a tooth fixed on the printing lever.

We are now considering the speedier recorders. These instruments also possess the great advantage of only requiring one line wire to effect the different movements.

The type-wheel in these, and in all instruments except the "Financial," is rotated by alternating currents.

A pair of electro-magnets, E and E', all the coils of which are in series, are fixed with the two poles of one facing the two poles of the other (see fig. 10), with about the space of ½ inch between them; in

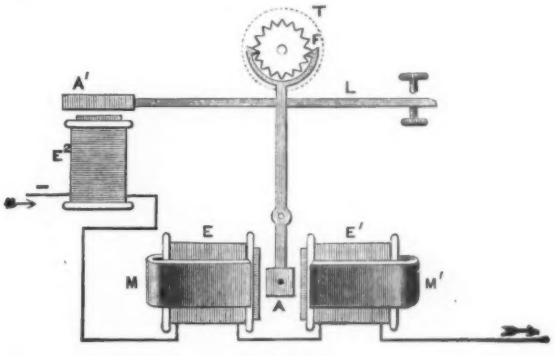


Fig. 10.

this space is placed an armature, A, lightly pivoted; it is kept in a highly magnetised condition by a pair of permanent magnets, M and M; so that here we have the best arrangement for fast working—a

pair of electro-magnets with a polarised armature. The alternating currents traversing these magnets cause a constant change of polarity, therefore, a repeated oscillation of the armature, which by means of the forked lever, F, turns the type-wheel, T, in the same way as the Financial.

Assuming we have got the type-wheel into its correct position, how are we to register it on paper, seeing that in this case we are only using one line wire?

Another electro-magnet, E^2, in series with the others, is so placed that on its armature, A^1, being attracted, it will bring a lever, L, into contact with the type.

You will naturally say "Yes; but as this magnet is in series with the type magnets, all the alternating currents of the one must pass through the others, and so you will have a continual attraction of the printing armature." This is true; but the alternating currents are of such short duration, only ·016 of a second, that the self-induction a weight is used as an auxiliary for driving the type-wheel; this weight must be wound up occasionally.

By experiment it has been found that when the transmitter is running at 100 revolutions a minute, the electro-magnets in these instruments have a "virtual" or "apparent" resistance of about nine times their real value, that is if you have a magnet of say, 3 ohms, as measured on a Wheatstone bridge, it will act with the rapidly alternating currents used, as though it were 27 ohms, consequently only $\frac{1}{9}$th of the current which would be given by applying Ohm's law. These virtual resistances increase in proportion to the speed of the transmitter.

I may here mention that by means of these transmitters, relays, and alternating currents, a very simple way of measuring self-induction is obtained. The method is a very practical one, and specially adapted for the magnets of this company, as they are tested under exactly the same conditions as they will eventually work with.

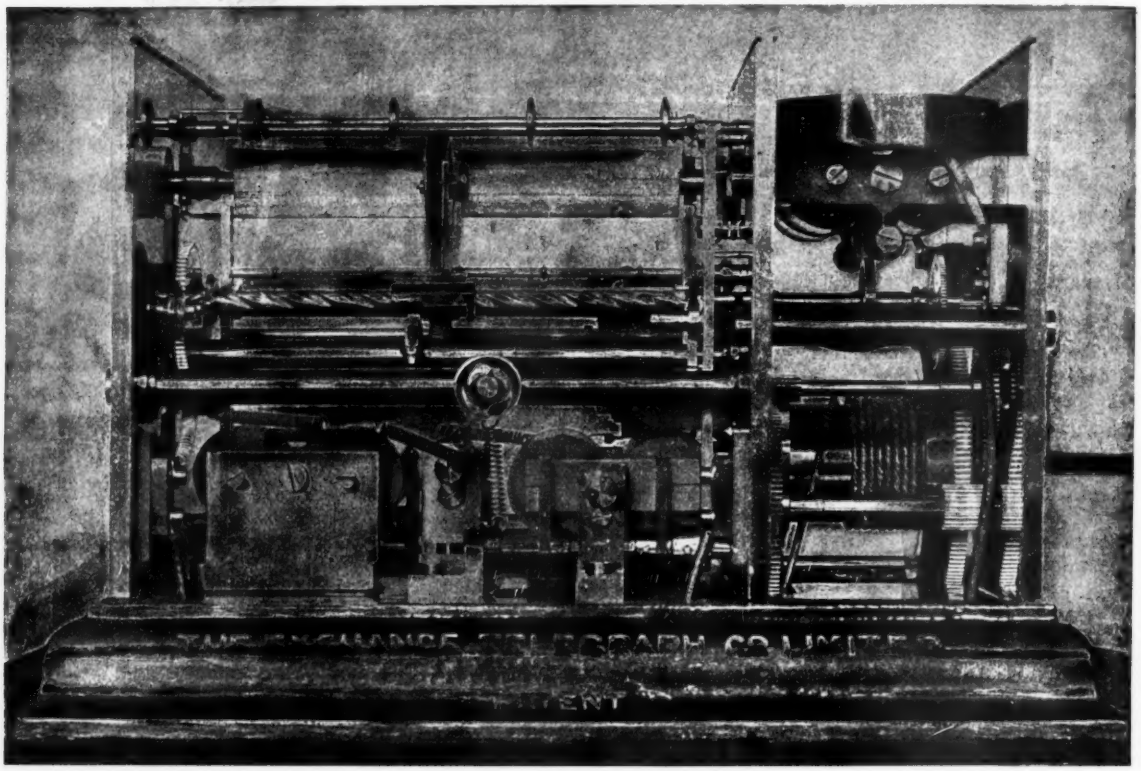


Fig. 12.

of the magnets will not allow the current to rise to such a strength as to magnetise the cores sufficiently to overcome the inertia of the printing lever, before another current has come and reversed the polarity, and so on; when, however, the operator presses his key, the alternating current ceases, with the cessation of the commutator, and

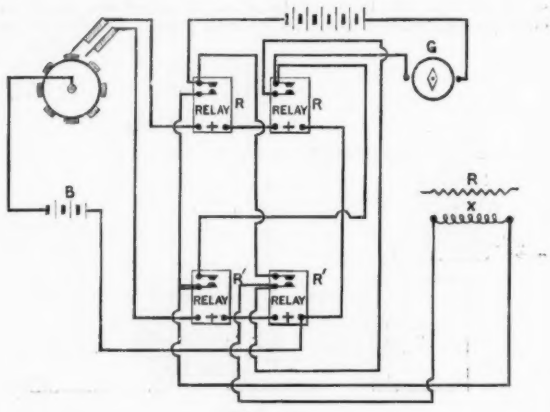


Fig. 11.

a continuous current is put to line for such time as he keeps the key pressed. This comparatively long current is able to attract the armature, and cause a letter to be printed.

For increasing speed in these and the Column printing instruments,

The connections are shown in fig. 11. You allow the current to flow through the magnet, X, to be tested; and through an ampere-meter, G, or a galvanometer, in which the deflections are proportional to the current, such as the thick wire coil of a tangent galvanometer; in series with the magnet coils. It will be seen that the circuit is arranged in such a manner that the current always flows in one direction through the galvanometer, though alternating in the electro-magnet. You run the transmitter to the required speed, which alternately closes the two sets of relays, R, R, and R^1, R^1, from the battery, B. The coil terminals of the relays have a + between them on diagram, the other two are the contacts. Now place the magnet to be tested in circuit, and note the deflection on G; you then switch the current off the electro-magnet, X, on to a non-inductive resistance, R, and adjust it till you get the same current as formerly; in this way you can exactly gauge the virtual resistance of your coil at any desired speed.

It is very necessary to keep all iron (except, of course, the core of your magnet) away while conducting the experiment, as a small piece in the neighbourhood of the apparatus will greatly influence the results. Of course these alternating currents differ slightly from those of an alternating current dynamo, as in the former there is a slight interval of time when neither brush touches the commutator, and consequently a pause between the alternations when no current flows; whereas in an alternator there is practically no cessation, for as soon as one current falls to zero, the one in the other direction immediately commences.

(3) *Column Printer Recorder.*—We now come to that class of recorder which prints its news not in one long line on narrow tape, but in column form; hence its name. A specimen of the printing is shown in fig. 12.

This is the latest and most ingenious of all these instruments, for in addition to other movements common to all printers, it has, when one line is finished, to bring the type-wheel back in order to start a fresh line. The type-rotating mechanism is exactly similar to that already described in the General News system. The printing is also effected in the same way. The type-wheel is mounted on a square

axle; running parallel with this axle, and at the back of it, is an archimedean screw extending the whole length of the instrument; on this screw is fixed a carrier which is free to run up and down the screw, having a thread on it.

On the printing lever is attached at right angles to it a rod terminating in a tooth clutch.

This tooth, when the printing lever is actuated, engages with a ratchet wheel on the screw with the result that when the lever is released by raising the transmitter key it pulls the axle round and forces the type wheel one pace forward. This repeated action gradually winds up a little spring which, when the end of the line is reached, is released and unwinds the archimedean screw, thereby bringing the type-wheel back for a fresh line.

Thirty-eight letters can be printed in one line, a space between words counting as a letter.

The operator is notified that he has finished one line by a dial on the transmitter divided into 38 divisions, over which a pointer moves, driven by an electro-magnet placed in the main circuit, which causes it to move forward one division every time a letter is printed.

A print of a "Column Printer" is shown in fig. 13.

I think you will be able to understand these movements more readily by examination of the instruments I have working on the table than by explanation.

A skilful operator can manipulate the transmitter to record about 35 words a minute.

If it happens that one or more of the type-wheels of the instruments get out of synchronism causing a "throw out," which may occur by the receiver missing one of the alternate currents, it is necessary that there should be some means of setting all the type-wheels of the instruments at one particular position from which it is possible to again make a fresh start, so that if the operator from time to time allows all his instruments to come to that point, he will provide against any subscriber losing a large amount of news.

This object is attained by an arrangement by which after a certain number of revolutions of the transmitter, about three or four, all the type-wheels are locked until the printing lever works. This is called a "unison" position.

There are several small details which you will notice on examining the instruments afterwards.

The "repeat" relay of which I spoke, is used for spacing out a large amount of paper, such as between messages; the contacts are reversed and the main current goes through them, consequently, when the electro-magnet is energised the contacts are separated and the circuit is disconnected until you release the repeat key.

The only advantage of this relay is for accomplishing the spacing more quickly than otherwise.

The ink for the type is supplied from a wheel, the periphery of which is covered with velvet for holding the ink; it travels with the type-wheel and maintains a rubbing contact, thus keeping the type inked.

The only attention necessary is to visit the instrument once in two days to furnish fresh ink and paper, and in cases where there is a weight, to wind it up. The letters on the type wheels are either cut out of metal or made of India-rubber, and afterwards mounted on the circumference of a metal frame.

I think this finishes the general description of the instruments.

To show the amount of work done on these recorders, I may mention that upwards of 306,000,000 words were sent on all instruments for the last half-year an average of about 2,000,000 words per day. The resistance of the instruments are usually about 12 to 15 ohms.

Various devices are in use for hastening magnetisation and demagnetisation, for instance, the coils of the type-wheel magnets are wound in two layers (fig. 14), as follows:—They are wound in opposite

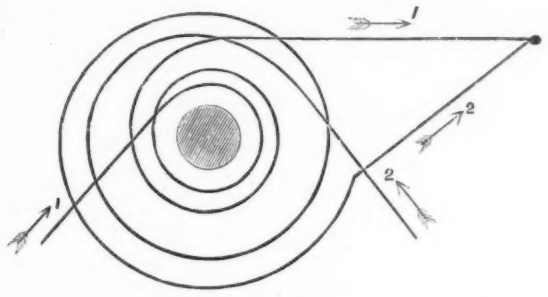


Fig. 14.

directions, and connected in the circuit in such a manner as to cause the inside and outside of each magnet coil to be of the same polarity under the influence of the current. The adjoining layers of the inner and outer windings are also of similar polarity.

This arrangement facilitates speed. In some cases the coils of the electro-magnets are joined up in multiple arc, for, besides increasing speed of working, it is found that you get half the magnetic effect, not for half the number of watts, but one quarter. This can be shown as follows, and here I quote from a paper written on the subject by Mr. Higgins, and published in the Institution's journal last year:—"If two exactly similar electro-magnets of, say, 10 ohms resistance each 1,000 turns of wire be employed, and one be connected in series in the usual way, and the other in multiple arc, the resistance of the latter will by so doing be reduced to 2·5 ohms.

"With a current of 0·5 ampère in the circuit the second electro-magnet will be magnetised by 250 ampère turns, and the series by 500 ampère turns; but the potential difference involved in producing the effect in the magnet connected in multiple arc is not a half but only one-quarter of that required for the series magnets. Thus, $\frac{5 \text{ volts}}{10 \text{ ohms}} = 0.5$ ampère × 1,000 turns = 500 ampère turns; $\frac{1{\cdot}25 \text{ volts}}{2{\cdot}5 \text{ ohms}}$ = 0·5 ampère divided between two coils of 500 turns each, or 0·25 × 1,000 = 250 ampère turns. That is, 2·5 watts in the first case; 0·625 watts in the second case.

"A further advantage, where speed is a consideration, is that the induced discharge, on closing the circuit, being of much lower intensity is more readily overpowered by the battery, and the magnetisation more promptly established. The discharge on opening circuit being also proportionately lower in potential, is more confined to the bobbin.

"Thus it will be seen that by this method of connecting electro-magnets, more effect for a given current can be obtained under certain conditions, or two magnets may be made to do the work of one at half the total expenditure of current required by a single similar magnet, and with greater promptitude in both charging and discharging."

Mr. Higgins has found that cores of electro-magnets which are short in proportion to their diameter are more suitable for speed than long slender cores.

The relays used have a resistance of ten ohms, and one is shown in fig. 15.

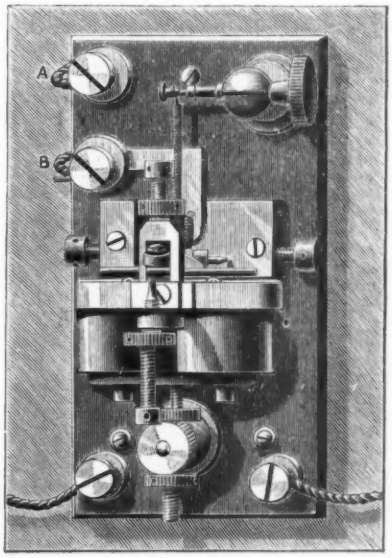


Fig. 15.

In these relays is beautifully shown what Mr. Higgins observed at a meeting of "Society of Telegraph Engineers" some years ago, viz.: that the sudden discharge from electro-magnets are not regulated by the usual laws of steady currents, and instead of passing through a spiral conductor of two inches of No. 30 or 24 copper wire, these sudden high electromotive forces will pass preferably by a shorter route made up of two thicknesses of lacquer and an air space, though this path may offer a resistance of some millions of megohms, whereas the other has only $\frac{1}{10}$th of an ohm.

This effect of high E.M.Fs., due to self-induction, can readily be shown in these relays when in actual use, as it is found that on breaking circuit at the relay contacts the discharge from all the electro-magnets will, if allowed to, not go by the path provided, but pass through the layers of lacquer on terminals marked A and B, and the air space between.

The difficulty is remedied by making the air space so long that it is impossible to form an arc.

The coil terminals are at the base of the drawing, fig. 15.

Current is supplied by accumulators, of which we have some 600 at the City and West End offices. The City cells are charged daily from a Gramme dynamo driven by a Pelton water-wheel, I think the second ever erected in England, and which works admirably, but I believe is rather expensive. In the West End the battery is charged from the electric light mains. In the event of a break-down to dynamo or motor it would be possible to continue work without any inconvenience for a fortnight before the accumulators would be discharged. They each have five plates and a capacity of 110 ampère-hours.

The average number of receivers on each circuit is about 16.

In most cases the wires are overhead; but only if unavoidable, underground wire is used; for short lengths this does not affect working.

In conclusion, I wish to express my thanks to Mr. Higgins for permission to read this paper on his instruments, and for the apparatus he has lent me, thereby enabling me to show the system in actual use, a great consideration when reading a paper dealing with complicated mechanisms such as mine.

D

REPORT ON DUST DESTRUCTORS FOR ELECTRIC LIGHTING FOR THE SHOREDITCH VESTRY.

THE following report has been made to the Vestry of the Parish of St. Leonard's, Shoreditch, by Messrs. J. B. Alliott, M.I.C.E., M.I.M.E., J. M. C. Paton, M.I.M.E., and H. B. Ransom, Assoc.M.I.C.E., on behalf of Manlove, Alliott & Co.:—

Gentlemen,—In accordance with the terms of the letter dated September 5th from your Vestry Clerk, Dr. Robinson, we beg to submit the following report on dust destructors and the utilisation of the heat generated therefrom.

Your questions relating to this subject have received the most careful consideration, and we are at length enabled to lay before you a tangible scheme that will fulfil the twofold purpose you aim at.

We have divided our report into five portions relating to the main features of the scheme, so far as it concerns us.

These are (*a*) The consideration of the form of destructor and its appendages most suitable for adequate and harmless refuse destruction in combination with steam generation.

(*b*) The storage of the heat generated.

(*c*) The useful application of such heat.

(*d*) Prime cost, working expenses, and profits sheet.

(*e*) Observations of a general character.

(*a*) In our opinion the points to which your attention should mostly be directed, when the type of furnace is under your consideration, are—primarily, the complete destruction of refuse in a furnace of the most simple and durable construction with secondarily as great rapidity of combustion as is consistent with efficiency, carried on at as high a temperature as is necessary for the dissociation of noxious gases and prolific steam generation. The difficulties met with in the burning of refuse are mainly due to the large amount of moisture and incombustible matter inherently present, together with the vast bulk of the material, compared with ordinary fuel. We should anticipate that the refuse of Shoreditch would contain quite 25 per cent. of moisture in even fairly dry weather, and the importance of this can hardly be over-estimated, as at certain times and seasons this percentage would be much increased. It must be remembered that no material of this calorific value will actually burn, either rapidly or at a high temperature, while the moisture remains combined in large amount with the combustible matter, and hence we consider that an effectual destructor must contain arrangements for the more or less complete drying of the material before coming into direct contact with the fire. This object is best attained by causing the heated gases or products of combustion to pass freely over and around the green refuse within the cell itself, thus in fact forming a system of local ventilation. The modes in which this ventilation is carried out in practice, together with the final disposition of the escaping products, distinguish the two main types of furnaces now in use. Thus there is the destructor in which the products pass from each cell into the combustion chamber and thence, over a secondary fire, through the boilers and up the chimney. There is a second in connection with which a secondary fire is only used for lighting up or occasional purposes, and in which the gaseous products are drawn to the front of the furnace and heated by the burning refuse. In the first type the products of combustion and distillation from the green refuse are as a safeguard passed over a fire which is entirely independent of the very variable temperature in the furnace cell, and good ventilation is also secured by the heated draught passing over and around the green refuse fed on the drying hearth, whereas the heat from the secondary fire may, if required by emergency, materially increase the steam-raising power of the destructor.

In the second the drying of the green refuse is solely effected by heat conduction along the brickwork and radiation from the fire, but the most important drying agent, namely, ample local ventilation, is quite wanting. The destruction of such noxious fumes as arise from the drying refuse is provided for by the heat generated in the same cell, but, as the temperature of the cell itself varies enormously, and no after provision whatever can be made for the destruction of escaping fumes, the second type cannot offer the same guarantee for adequate fume destruction as the first, and the sole objection to the first disappears at Shoreditch, where steam generation is of importance.

About fifty destructors of the first type have been erected in this country, and, owing to its simplicity and solidity, it is by no means unusual to find instances where the burning has never ceased day or night during five or six years at a stretch. The average rate of burning under natural draught may now be taken at about seven tons per cell per diem of twenty-four hours, although cases have been authenticated where as much as ten tons per cell per diem have been destroyed. Perhaps the most recent and best of the second type (of which about four or five are still at work) is that erected two or three years ago in the North, where it is stated that something less than six tons per cell per diem are burned. We attribute this somewhat meagre burning capacity very largely to the lack of local ventilation around the green refuse.

Among details of construction which are peculiar to neither type of furnace may be classed:—Automatic feeding or charging arrangements, forced draught, rocking firebars, and independent dampers to each cell.

Numerous inventions have been made during the past few years for the purpose of charging destructors automatically. The variable nature and character of refuse renders this an end difficult to attain, because any mechanism is liable to get clogged and cause more labour in cleansing than actual charging by hand. These appliances are also commonly used in conjunction with conical hoppers into which the carts tip direct. Our experience leads us to believe that in your case the refuse would have a great tendency to get jammed in the hopper, if of this shape, and be the fruitful source of trouble. The charging apparatus, as in use at Liverpool on a twelve-cell destructor, with certain modifications appears to us, however, to meet most of our criticisms, and from recent enquiries we gather that the City engineer, Mr. Percy Boulnois, M.I.C.E., looks upon this as a great success. The hoppers are of rectangular form, and of sufficient capacity to hold a night's supply. The refuse is discharged in suitable portions and at required intervals direct into the cells, without ever coming into contact with any mechanism other than a trap door. Not only is the refuse not handled from the time that it is collected by the carts until discharged into the furnace, but it has been found that two men (in the near future it is contemplated using only one man) are sufficient to charge the whole of the twelve cells, instead of the four men required at the adjacent 12-cell destructor where hand-charging is still in force. In this way about £300 a year is saved in working expenses for a comparatively small increased initial outlay.

With regard to forced draught, we believe that most authorities have agreed that it tends to promote high temperatures and rapid combustion, and its adoption is therefore especially desirable for a steam-raising destructor. We must, however, say that if applied by means of steam jets, although possibly the cheapest in first cost, the regular attendants have a just ground for complaint owing to the deafening roar of the escaping steam, while the addition of further moisture to already saturated refuse cannot be but prejudicial to perfect combustion. We therefore propose that, instead of propelling the air into the ash-pit by means of jets, the air be forced under the grate by means of a separate fan or blower driven mechanically, and to attain what advantage there is to be gained from a moist draught by utilising the moisture inherently present on the refuse without further addition.

We incline to this modification more readily because we are of opinion that sufficient air can be delivered to each cell with less expenditure of power by the agency of a blower than by means of a steam jet.

Opinions as to the value of rocking firebars differ to a great extent, but as in any case their adoption is not a matter of vital importance, we certainly do not think that it is worth while encumbering the furnace fronts with complex revolving shafts and worm wheels for the sole purpose of giving continuous motion to the fire-bars. It is probable that some labour may be saved to the attendants if the fire-bars can be rocked intermittently by pulling a handle when required for the purpose of breaking up or loosening clinker.

We regret to say that most forms of moving fire-bars leave much to be desired; those in use at the Powderhall destructor, Edinburgh, in our opinion, meet the difficulties with most success.

The object of independent dampers to each cell was primarily to prevent unconsumed dust, &c., being blown over into the combustion chamber when the fires were being clinkered, but they have hitherto met with only moderate success in this direction. They have, however, a secondary object, which is of some importance in cases where uniform high temperatures are desirable for steam raising or other purposes, seeing that they effectually check the inrush of cold air into the main flue at such periods. We think that such dampers should be connected with the corresponding cell doors, so that the dampers will close automatically when the cell doors are opened for any purpose.

The precise arrangement and construction of the boilers will, to some extent, be determined by the site, and therefore but little can be said of them at present. We are, however, strongly of opinion that they should be of such strength and dimensions as would be suitable for work in conjunction with Mr. Druitt Halpin's thermal storage scheme, to which we shall again refer.

A brief reference to the chimney will conclude the explanation of our views as to a suitable destructor for Shoreditch.

The use of forced draught to some extent replaces the function of a chimney, but it would be mistaken wisdom to reduce its height beyond a certain point on that account. Experience has shown that in several instances where diminished height has been suggested, it has been ultimately, and perhaps wisely, negatived, and the reasons which have led to this decision would probably apply to Shoreditch.

(*b*) *The Storage of the Heat Generated.*—We believe that the scheme of thermal storage is not entirely new to you, as we understand that in the previous report of your electrical engineer, Mr. Manville intended to adopt this as the best means of utilising heat for electric lighting purposes.

In considering this question, it must be remembered that the heat from a destructor is being generated with tolerable uniformity every hour of the twenty-four. The power which can thus be obtained during any one hour is comparatively insignificant compared with the maximum required, say, in a central station of very moderate dimensions, but would certainly exceed that required during the greater portion of the 24 hours. Hence, if the destructor is to be the sole generator of steam for the electric lighting stations, it is necessary to have some system for storing the excess of power generated (during those hours when the electric light is but little used) in such way that it can be drawn on as required during the hours of darkness.

The great cost of storage batteries excludes their adoption for the entire storage of the excess energy, otherwise this might be looked on as an alternative scheme. These remarks, of course, do not apply to the use of accumulators at sub-stations. Prof. Unwin, F.R.S., states that the capital cost of electrical storage amounts to £8 per electrical H.P. hour against about half that sum for thermal storage, and we have ourselves confirmed this relative cost by actual enquiry among the leading accumulator manufacturers. So far as we are aware, the only scheme which can be considered as a practical mode of dealing with the question is that invented by Mr. Druitt Halpin, M.I.C.E. Instead of generating electricity, and then by costly means storing it indirectly, he proposes to store that by means of which electricity is

produced, namely, heat. Under this system, which depends on well-known principles, the central station will be provided with engine power equal to the maximum load, but the destructor and boiler power will only be required equal to about one-fourth of the maximum load. These boilers will also be working under the best and most economical conditions, because they will work continuously at their most efficient load, and no banking up or stand-by losses will be incurred. They will be constantly employed generating high pressure steam, and passing it into a sufficient number of cylindrical receivers, in which it will raise water to and maintain it at a temperature nearly equal to that of the steam generated in the boilers themselves. This water so heated will when wanted give off steam at the pressure used in the engines and at any required rate to meet fluctuations of engine load.

There is an additional advantage obtained by this system, which may prove of great value to the vestry. We propose to pass all feed water first into the storage cylinders and thence into the boilers as required, and hence such deposits as would with ordinary arrangements take place in the boiler itself, would in your case occur only in the cylinders.

A deposit in the storage cylinders does no injury, because no portion of them is in contact with the flames, and being of comparatively simple construction they can readily be cleansed. Mr. Michael Longridge, M.I.C.E., of the Manchester Boiler Insurance Company, Limited, was consulted as to the importance of this very question, and gave it as his opinion that although the first cost of a complete plant for an electric lighting station might be increased by the addition of thermal storage, he was satisfied that there would be a large annual saving in the item of depreciation and fuel by its adoption. This view is confirmed generally by Mr. William Schönheyder and others.

You will notice that our views on this scheme of thermal storage are thus confirmed by several independent authorities, and we therefore have the greater confidence in advising you to adopt this system. We believe it to be the only possible scheme which offers a reasonable means of utilising to the utmost the power that your destructor will be capable of generating.

(*c*) *The Useful Application of the Steam.*—We are informed by Dr. Robinson that it is proposed to utilise the heat for two purposes. (1) The electric lighting central station, and (2) for the baths and wash-houses. We have been able to go into the first portion of this scheme most carefully owing to the great courtesy of Mr. Manville, who has kindly afforded us information as to the probable initial demand for lighting. We gather that the average daily winter load on the central station may at the start be taken at 100 kw., and considerably less during the summer months. We have also inspected the books under the care of your manager at the Wharf with the view of ascertaining the probable supply of refuse during the winter and summer months.

We have come to the conclusion that there will be sufficient refuse both summer and winter to meet the demands of such a central station as that proposed by Mr. Manville, provided that the thermal storage system previously referred to be included in the general scheme.

We understand that the probable annual expenditure in coal for the baths and wash-houses would amount to £500. We therefore visited an establishment of similar proportions belonging to a vestry in your neighbourhood to ascertain the fluctuation in the demand for steam, and obtained sufficient particulars to enable us to form a general opinion. We think that the steam from the destructor, under ordinary conditions as to the supply of refuse and the demand for power, would probably prove sufficient to meet the requirements for electric lighting, and also those for baths and wash-houses. We must, however, remember that provision has to be made for emergencies; a fog, for instance, may suddenly cause the average daily demand for light to be almost doubled, or inclement weather may prevent the adequate collection of refuse. Again, it has been found by experience that electric lighting central stations develop in magnitude with great rapidity, and provision has to be made in some portions of the initial plant for such extensions. Although these difficulties can easily be dealt with by simple expedients provided for in our estimate, we incline to the belief that it would be prudent on the part of the vestry in the first place largely to confine the utilisation of the steam from the destructor to the more important scheme of the two, namely, electric lighting. We should, however, suggest that the bath water be heated by the exhaust steam from the engines and so, not only fulfil a useful purpose, but also increase the power of the engines.

If, when this plant is started, it is found that the steam generated is not likely to be adequately utilised by the electric lighting engines, it will still be an easy matter to carry a live steam pipe to the baths and wash-houses, provided that they be within reasonable distance. We believe, however, that the chances are that eventually the whole of the steam raised will be most remuneratively employed in generating electric light.

ESTIMATE No. I.—CAPITAL.

Dust destructor generally in accordance with recommendations embodied in the text of our report, including chimney, inclined roadway, buildings, foundations, mortar mill, weighbridge, and tools ...	£8,800
All necessary steam generators, pumps, piping, steam storage appliances, and buildings	£8,700
	£17,500

The above includes the complete steam generating plant for electric lighting central station, or other purposes, and includes provision for extensions.

ESTIMATE No. 2.—REVENUE.

Value of steam generated and used for electric lighting engines, baths and wash-houses, value of mortar and clinker used by vestry and contractors...	£4,290

ESTIMATE No. 3.—MAINTENANCE.

Depreciation and interest on capital, rents, rates, &c., water, lighting, coke, oil, waste, stationery, insurance, lime for mortar, wages and salaries ...	£2,800
Contingencies	100
Total	£2,900

The cost of dust disposal alone, apart from expenses in connection with complete utilisation of heat, should not exceed 1s. 6d. per ton.

PROFIT AND LOSS ACCOUNT.

From revenue	£4,290
Total expenditure	2,900
Profit	£1,390

Comparison of expenses of new scheme with those involved by coal-fired boilers without thermal storage and present system of dust disposal:—

Total annual expenses of proposed scheme, allowing nothing for mortar and clinker	£2,900	Steam from coal-fired boilers	£3,830
		Present cost of refuse disposal	£3,400
	£2,900		£7,230

Annual saving on new scheme ... £4,330.

It may be noticed that no allowance has been made in the foregoing balance-sheet for screening of the refuse on a large scale. This has been omitted, because we are of opinion that, firstly, little advantage is to be gained to compensate for an expenditure of from 6d. to 1s. per ton, and secondly, that the primary object of dust disposal is defeated, since the screened refuse has still to be dealt with, and the process is not one to be recommended on hygienic grounds. These criticisms do not apply to cases where, as at Hampstead and elsewhere, a small portion of the refuse is riddled to separate breeze for the purpose of burning in the secondary fire. Provision has been made in the working expenses to allow this to be done, should it be found profitable. We have further debited the destructor with the costs of its own lighting, at the same rate as that which other consumers pay, and due allowance has also been made for interest on capital, depreciation on all buildings and machinery in connection with the works, together with rents, rates, &c., on the terms stipulated by Dr. Robinson.

We have drawn up the credit side of our balance sheet as if it were for that of an undertaking dealing with an electric lighting corporation. We therefore consider ourselves justified in charging a price for steam approaching that which it costs similar existing metropolitan electric companies at the present time. We understand that in 1892 the average expenditure on fuel alone (*vide Lightning*) at the four most economical stations, viz: St. James's, Westminster, Kensington, and Chelsea, amounted to about 1d. per unit; at some other stations it was quite double this, and we estimate that the additional cost under similar working conditions involved in boiler-house wages, depreciation, water, &c., would, in the case of Shoreditch, increase this cost by at least 0·1d. per H.P. hour. Whilst dealing with the price of steam, we may point out that if the steam produced were sold to any ordinary commercial concern, such as modern baths and wash-houses, we should only be entitled to charge about ½d. per H.P. hour, owing to the fact that the working conditions of such undertakings are so entirely different. Hence, if the vestry expend all their steam on generating electric light, the advantage they derive will be much greater than if they made use of the steam for baths and wash-houses, or other similar purposes. You may also note that we have made allowance for sale of clinker and mortar, although we are well aware that in some instances difficulty has been experienced in effecting such sales. We know, however, that large quantities of clinker are annually sold in your immediate neighbourhood to contractors and others, and also, undoubtedly, a quantity might most satisfactorily be employed by the vestry in its own works, or in those undertaken on its behalf. There is one item for which we have credited nothing to the destructor. We should anticipate that you would be able to burn during the next few years more refuse than can be collected in Shoreditch itself, and we should therefore suggest that an arrangement might be come to with neighbouring parishes for the disposal of a portion of theirs also. Thus, assuming that your neighbours pay contractors the same amount per ton as that Shoreditch at present expends, they would doubtless be glad to economise and deliver at the destructor say 5,000 tons per annum, and make you a sufficient payment for its disposal. You might thus not only obtain a profit on the disposal, but would also increase the steam generating capacity of the plant.

Before concluding our report, we venture to point out to you that sooner or later a system of dust disposal by fire is one which circumstances are almost certain to commend to you as a necessity. The great strides that have been made of late years in the design of suitable destructors, combined with the changed character of the refuse, have rendered objections to their use so baseless, that they can now be placed only on æsthetical or sentimental grounds. We believe that nearly every vestry in London contemplates adopting, or has

adopted, some such means of dust disposal as the one we indicate, and experience has shown that the longer such a course is deferred, the more expensive will be its ultimate adoption. In the country this line of action is even more strongly emphasised. Among the 46 towns, each containing upwards of 60,000 inhabitants, excluding the Metropolis, there are distributed more than 60 destructors in actual operation, and there is every probability that ultimately a dust destructor will be looked upon by municipalities as being as essential as their own town halls.

We desire especially to emphasise the fact that the use of the destructor by itself will effect a large saving (at least £1,500, including repayment of loan) on your present expenses, even without any complete utilisation of its heat; but as the derivable steam power is as much a bye product as the very clinker and ashes, albeit of well recognised and far greater value, we cannot but think that it would be short-sighted policy to permit it to be wantonly wasted now that means of utilising it for public purposes are clearly available.

We are of opinion that the power should be used to the utmost and in the most remunerative way, namely, for electric lighting, on which combined scheme we should anticipate a further saving of more than £2,000 per annum.

MANLOVE, ALLIOTT & CO., LIMITED.
Per JAMES B. ALLIOTT.
J. M. C. PATON.
H. B. RANSOM.

57, Gracechurch Street, London, E.C.
December, 1893.

A LOUD-SPEAKING TELEPHONE.

THIS apparatus, devised by Mr. Graham, of the Electric Wiring and Fittings Company, Limited, is designed to supersede the telephones now in use, and, as its name implies, is really a loud-talking instrument. The receiving portion of the apparatus has the merit of being so powerfully responsive to the electric current, that the voice of a person speaking to the apparatus at one end of the line, in ordinary tones, can be distinctly heard in all parts of a room at the other, and this without the listener or listeners having to place the receivers to the ear or to move from their seats. There are no bells required, the loudness with which the voice is reproduced being quite sufficient to call attention at either end. The apparatus is capable of very many applications by reason of its simplicity and strength, and is not liable to get out of order.

The company has also designed for use, with the loud talking apparatus, a system by which any room in a building may communicate *direct* with any other room; the only additional apparatus necessary to accomplish this being a switch, thus doing away with the complex apparatus and exchange systems at present in use.

We have personally inspected and used these telephones, and we can conscientiously say that no description can possibly do them justice. They beggar all description, and must be seen and heard to be believed. They are no laboratory instruments, but simple, reliable, practical telephones, which anybody can at once use. This latest development in loud-speaking telephony will create a real sensation, and it ought also to revolutionise our present systems of working.

Those who object to talking being plainly heard all over the room can, at pleasure, substitute a receiver which is held to the ear.

Graham's telephone is certainly an enormous advance on anything we have previously seen, for its articulation is perfect, and its loudness is simply wonderful. We should imagine that for railway companies, ships, factories, anywhere indeed where noise is incessant, these telephones would prove invaluable, and as for ordinary telephonic communication in cities—well, it is too much ever to expect or even hope for.

CORRESPONDENCE.

Testing for "Grounds."

With reference to an article in your issue of to-day's date, may I bring to your notice the method in use here for locating "grounds" as one which requires *absolutely* no disconnections in a complete network of wires, and is thereby an improvement on that of Mr. Latch.

The direction of the current due to putting on an earth resistance as described, is noted by laying a pocket compass on the conductor, and bringing the needle parallel with it by means of a strong bar magnet before making the "earth-seeking" current. By this means a "ground" can be, and has been, traced by two men in from half-an-hour to an hour and a-half, and without lifting more than six or eight junction boxes, no disconnections whatever having been made. This method has been fully described in public, and I need not therefore go further into it.

A "ground" in a series arc lighting circuit is found by first taking the difference of potential between one end of the circuit and earth. This is, of course, the same as that between the end of the circuit and the fault; the fault is thus located between two lamps. If it is necessary to find the exact position of the fault, a sensitive portable galvanometer is taken to that part of the line. A resistance is put in circuit such that the difference of potential across it is the same as the drop on 100 feet of line. The ratio of the galvanometer deflections, across the resistance, and from line to earth, gives at once the fraction of 100 feet that the fault is distant.

Wm. Rowan Wilson.

Glasgow Corporation
Electric Lighting Station, *May 18th*.

Blackening of Lamps.

I read your report of the discussion on Prof. Anthony's paper on "Blackening of Lamps." As Prof. Anthony quoted an earlier paper of mine on "Molecular Shadows in Lamps," but made no reference to a later one in 1885, I send you a copy of this latter. There seems a disposition to claim as new the idea that the blackening is due to evaporation of carbon. You will see that I have stated in this 1885 paper the conditions under which the deposit is apparently due to a general evaporation, and where to a projection giving rise to a "shadow." Out of 100 lamps which are blackened, not 5 per cent. show the shadow. I have a collection of lamps of all kinds, which I have frequently exhibited at lectures, which show conclusively that shadows are produced either by a very high temperature at one spot, or by a very localised high temperature in the filament.

J. A. Fleming.

[We have read the pamphlet which accompanied Dr. Fleming's letter, and it appears to bear out what he says.—EDS. ELEC. REV.]

A Substitute for Selenium Cells.

The following is a suggested substitute for the selenium cell. It consists of a delicate microphone made of two carbon filaments, one resting lightly on the other. To the top filament is attached a thin mica plate, blackened on one side like the vanes of a Crookes radiometer, and the whole is inclosed in a high vacuum. When light falls on the blackened surface of the mica plate the carbon contacts are pressed together, thus altering the resistance of the circuit. I think that this simple device might be useful for operating relays, &c., or possibly it might be used as a photometer or thermostat.

E. B. Viles.

May 19th, 1894.

The Cost of Electrical Energy.

In your generally accurate report, I am credited with one or two remarks, in speaking on the 10th inst. at the Institution of Electrical Engineers, which I should like to be permitted to set right. I much regret that absence prevented me from correcting the proof which, by your courtesy, was sent to me. A mistake will probably be suspected when I am made to say that at Thames Ditton we always fit steam pressure gauges in our electric launches, because we do not build electric launches, and if we did, there would, presumably, be no steam in them. Formerly we built steam launches, and the allusion was to the pressure gauge which we always fitted to the steam chest of the engine, so that those in charge, having previously calibrated the vessel, so to say, could tell at a glance approximately what power the engine was giving, and approximately at what speed the boat was moving. An allusion to the experiments of the late Mr.

Willans may also be misunderstood. What he showed was that in a Willans engine, coupled direct to a good dynamo, the total losses of the two were approximately constant at all loads; it is a fair deduction from this that the engine losses are constant. The four "kinds" of engine friction should be four "sources" of engine friction, and there are some other points which, however, it is not worth while to trouble you about.

Mark Robinson.

[We are glad to give publicity to Mr. Robinson's corrections, and regret that we were unable to make them in our last issue.—Eds. Elec. Rev.]

Howes's Electric Lamp Pendant.

In your issue of the 11th inst. you give an account of a telescopic pendant and floor lamp arrangement, the invention of which is attributed to a Mr. Howes. May we point out that on March 7th, 1893, our Mr. New patented this improvement, and that we have since then fitted up many standards with it.

Hoping that you will correct the erroneous statement,

New & Mayne.

Electricity Meters.

I must apologise for further trespassing on your space, but as Mr. Kennedy's statement is inaccurate, I trust you will allow me to correct it.

He accuses me of having said that the "use of a step-down transformer to reduce the pressure in a known ratio on a measuring coil or instrument was originally used by Prof. Elihu Thomson," but on reference to my paper you will see that the statement actually made was that in the Thomson-Houston primary wattmeter the volts for the shunt coil are reduced by means of a transformer.

The use of a transformer on high tension circuits in connection with a low tension voltmeter has for very many years been common property, but there is nothing in Mr. Kennedy's paper to which he refers me or from end to end of Mr. Swinburne's book, which so much as suggests the possibility of using a transformer in connection with the shunt coil of a primary wattmeter measuring true watts on an inductive load. If his patent, which he believes is No. 6,201, does contain any such suggestion, his priority is established, but this particular patent, curiously enough, is abandoned, and is therefore not obtainable.

It will be seen, therefore, that Mr. Kennedy's veracity is no more obvious than his priority, and under these circumstances I must decline to discuss the matter any further.

R. Wilson.

Reckenzaun Motor and Gearing.

In the description of this gearing and motor, a table of results of tests is given, page 569 of Review for May 18th, purporting to be taken as the efficiency of the motor and gear combined. I cannot understand that table, and would be much obliged if Mr. Dawson will oblige by explaining it. What puzzles me is, that the "outputs" are more than double the "inputs." This may be a printer's error, transposing the column headings; if it is so, then the efficiency is usually calculated by $\frac{\text{output}}{\text{input}}$ = efficiency; but in the fourth column we find the square root of a fraction over 0·93 used to find the efficiency which comes out about 72 per cent. Whence cometh the square root of the 0·446? and why divide it by 0·93?

By $\frac{\text{output}}{\text{input}}$ the efficiency comes out a little over 40 per cent. The belt of course, is extra, and should be allowed for, but still this method of securing a result equal to 72 per cent. requires some explanation.

Furthermore, the tests made to ascertain the efficiency of the worm gearing were made with small powers, the highest being 2·31 horse-power; but as worm gearing falls in efficiency as the load increases, it would be satisfactory to have the results of tests up to the full power of the motors on the car, say, to 20 horse-power.

Rankin Kennedy.

Self-Lubricating Bearings.—We have received a letter from Mr. R. A. Goodman, in which he reiterates his former remarks on the subject of self-lubricating bearings. We regret that we cannot publish it in full, but the matter has become a personal one, and the correspondence must now close.

THE POSITION OF THE CONSUMER OF ELECTRICITY.

The position of the consumer who derives his supply from the mains of a company or corporation working under the powers of a provisional order has been safeguarded in some respects by special clauses in the Electric Lighting Acts under the authority of which provisional orders are granted. He is also supplied with electrical energy under a system which must be designed and worked in accordance with the rules and regulations of the Board of Trade, as to safety and as to supply, but these legislative safeguards do not and cannot protect the interests of the individual consumer unless the spirit as well as the letter of the law is adhered to by those who undertake the supply. When the supply of electricity was confined to the wealthy, the principal safeguard of the consumer's interest was the fact that unless a satisfactory supply were given, custom would be prejudiced, and electric light undertakings would never become paying commercial concerns. This was the position of things at the time when the Amendment Act of 1888 was passed. Provisional orders had been more or less drafted upon legal analogues, and the conditions which it would be necessary to embody in them when electricity supply was given on a large scale, and by competing firms had not been at that time as carefully considered as was very soon afterwards found to be necessary. We are to-day in a much more fortunate position. It is recognised that the true interests of undertakers are at one with those of the consumer, and experience has proved that electricity supply companies are only too anxious to fulfil all their obligations and to make their business a sound commercial one provided that the restrictions and conditions imposed upon them are not such as to seriously hamper the industry. While this is so, there are many points raised by the heated competition which exists in London between the different companies, and which also obtains in the provinces to a less degree, due to the competition between electricity and gas, oil, and other illuminants.

Manufacturers who have to generate steam in large quantities for their own use, met with a somewhat similar set of conditions some years ago. These led to the formation of various steam users' associations, which were in the main money-making corporations, although they aided the owner and user of steam-power plant very materially. A very good example is the Manchester Steam Users' Association, and the success which has attended the working of this concern has led to the formation of a similar association in connection with those who generate and use electrical energy. The Electricity Users' Association, Limited, which has recently been formed is, if successfully pioneered through its early difficulties, likely to become a feature of importance in the electrical world. It has adopted a policy which, on the face of things, gives it a very high standing. The first idea was that the major portion, if not the whole, of the practical knowledge in this country regarding electricity supply was possessed by resident engineers—those who have actual experience in the erection and maintenance of central station plant, and who may be said to be pioneering the future of electric lighting. Following this principle, the Association put themselves in touch with the leading managing and resident engineers in England, and have succeeded in convincing the majority that the work to

be done would not only be worthy of them, but that, with their assistance, it could be well done. Mr. D'Alton, of the London Electric Supply Corporation, Limited, was chairman of a meeting recently held and at that meeting was elected to the presidential chair of the Association. Considering the early formation and the up-hill work which his company has had to undertake, to say nothing of their possessing a scheme which in its technical aspects has had an important bearing on the industry, whatever opinion we may hold regarding the commercial advantages possessed by it, Mr. D'Alton is the right man in the right place on any association which intends to represent both the interests of those running electric light stations, and of the consumers supplied by them. The vice-presidents are Mr. Arthur Wright, Mr. R. C. Jackson, and Mr. John Hesketh, two of whom are running high-tension stations, one of which has been noted for its remarkably economical results, while the third is now identified with direct-current supply. At the same time, Mr. Arthur Wright may lay claim to have been among the few who successfully conducted high-tension enterprises in the days before any text-books had been written regarding the theory of alternating converted supply. Fifteen out of the twenty-seven members of council are resident engineers to Corporations, who are themselves undertakers under the Electric Lighting Acts. Indeed, the constitution of the council as a whole is one which for strength and general excellence has never been surpassed.

The objects of the Electricity Users' Association may be put into a very few words. The Association practically resolves itself into a body desirous of performing the functions of a consulting engineer, as well as to some extent those of an insurance office, although the latter portion of the scheme has not yet been fully developed. No doubt there are many objections which could be raised to even the most plausible prospectus of an association formed to undertake such work, and it largely depends upon the way in which performance is carried out whether the association will, or will not, be assisting the industry generally. The first criticism which might be advanced would be to call into question whether the title of the Association is not a misnomer, although we should be quite prepared to be met with the statement that, so far as the title went, it was merely modelled upon that of similar associations dealing with steam power plant. The object of the association is clearly to give advice as to systems of supply, and it would deal with the drawing up of specifications, the execution of the contracts, and would advise upon questions arising during regular working; maintenance, redemption, the effecting of economies, &c. On the other hand, it undertakes to protect consumers where their interests may clash with those of the undertaker. For this purpose it would make an annual inspection, so that the condition of an installation could be ascertained, whether any repairs were necessary, and how far efficiency in the utilisation of electric energy could be increased. If this work be done conscientiously, the charge which it is proposed to make of £1 1s. per annum is certainly not excessive, and a balance of power will probably be maintained on the council, inasmuch as the engineers to the association—Messrs. Wilson and Clirehugh—are not directly connected with any central station undertaking, and as the association, as a whole, would carry out any work entrusted to it. We already have the Institution of Electrical Engineers as an arena in which to debate questions of general electrical engineering interest, while the London Chamber of Commerce and the Physical Society are quite competent to take care of purely commercial and purely scientific matters affecting the electric lighting industry, but we have, as yet, no institution or society which has, for its main object, the protection of those in whose hands the actual running of central stations lies.

The electric inspection clauses of the various provisional orders which are in force have yet to be brought into play. In only some five cases do the ratepayers possess officials to look after their interests. Liverpool in 1889 appointed the first electrical engineer who would discharge the duties of an electric inspector. Bath and the London County Council followed a few months afterwards; while Toxteth Park and Birmingham were not very long before they recognised the importance of appointing such an official, but the expense attached to such an appointment has, in many cases, militated against the operation of the protective clauses. It is not every corporation which can afford to equip a laboratory and appoint a man of suitable attainments and standing to discharge the duties of such an office, and here the Electricity Users' Association certainly can make out a good case, provided that they employ men who have had some experience in this class of work to actually carry out any work of this nature entrusted to them. Although the association is purely a limited liability company, we attach much more importance to the policy which will guide them in carrying out the object for which the incorporation has taken place, than to mere statements in the prospectus, or what is alleged to be the policy guiding them in the formation. We may have something more to say regarding this when we have had the opportunity of considering a little more carefully what the true meaning of the various papers issued by the association may be.

NOTES.

Alternate Current Electrolysis.—A paper on this subject appears in the *Proceedings* of the Royal Society, liv., pp. 407—417, under the joint authorship of Dr. J. Hopkinson, E. Wilson, and F. Lydall. It is worthy of the most careful study by those who are interested in the developments of commercial electrolysis. The objects of the research which this paper describes were to determine (*a*) the dissipation of energy due to electrolytic hysteresis, and (*b*) the quantity of an ion per square centimetre of an electrode necessary to change the properties of the electrode to that of the ion during alternate current electrolysis. The method of experimenting consisted in passing an alternating current through an ordinary non-inductive resistance, and through an electrolyte, and then measuring the difference of potential at the extremities of these two resistances at different phases of the current. By this means it was demonstrated that with platinum electrodes of 150 sq. cm. area, the ion being hydrogen, the maximum E.M.F. due to polarisation was reached when $\frac{1}{10}$th of a coulomb had passed through the cell, that is, when 0·00001 gramme of hydrogen had been liberated. Hence 0·00000007 gramme of hydrogen is sufficient to polarise 1 sq. cm. of platinum. By assuming that the density of hydrogen is comparable with that of liquids, the thickness of the film of hydrogen necessary is 0·00000007 cm., a number which is suggestive of the distance between the molecules. The paper is well illustrated with curves of current and potential differences with different frequency, and also with curves which exhibit the dissipation of energy per cycle.

Some Curious Electrical Phenomena. — Petroleum spirit, or benzine, is a substance which is largely used in the silk and wool industries, and in "chemical cleaning" works, as a solvent for greasy impurities. It is an extremely volatile liquid, and has often been suspected of being the cause of those mysterious fires which occasionally break out in works and factories where it is much used. In such cases it has been supposed that the inflammable vapours which the liquid gives off, must in some way, have gained access to a light. The ignition of petroleum spirit has now been shown to be "spontaneous," and to be caused by electrical excitation. In the cold, dry days of winter, especially, the spirit becomes excited, sparks and flashes of light are seen, accompanied by crackling sounds; and if no provision be ready for interfering with the phenomena, the spirit may soon be ignited. In Germany, Kissling has recently recommended that a small quantity of some kind of soap, soluble in petroleum spirit, be dissolved in it; this prevents the electrical excitation, even when so little as 0·2 to 0·3 per cent. is added. The use of soap upon spirit that is in a state of excitation also allays it, and the danger of ignition is avoided. The excitation of petroleum spirit is never observed in a moist or warm atmosphere, the conditions being favourable either for carrying off or preventing the manifestation of the electricity. The use of the soluble soap possibly provides the necessary moisture, water being otherwise non-miscible with petroleum spirit.

The Cost of Electrical Energy.—We would draw the attention of those interested in the discussion on Mr. Crompton's paper to some corrections of Mr. Mark Robinson which appear in our Correspondence columns. It was unfortunate that the corrections were not made in our report of Mr. Robinson's speech, but owing to the intervention of the Whitsun holidays, we did not receive the corrected proof till long after some of our pages had gone to press.

Thieves Difficult to Arrest.—Mr. W. S. M'Millan, of Mason College, Birmingham, relates, says the *Globe*, that he once saw a crow's nest of iron wire (probably telegraph wire) in an old tree at the Cossipore Ordnance Factory, Calcutta. Last year, he also observed an Indian crow drop a crumpled piece of iron wire, 23½ inches long (35½ when stretched even), and of No. 11 Birmingham wire gauge. It weighed nearly 861 grains. The bird was not far from the old nest found in the tree. Indian crows are well known to pilfer scraps of telegraph wire for building their nests.

The Royal Society.—The following papers were down for reading before this Society yesterday afternoon:—"Measurements of the Absolute Specific Resistance of Pure Electrolytic Copper," by J. W. Swan and J. Rhodin; "On some Voltaic Combinations with a Fused Electrolyte and a Gaseous Depolariser," by J. W. Swan; "On the Measurement of the Magnetic Properties of Iron," by Prof. T. Gray; "Researches on the Electrical Properties of Pure Substances. No. 1.—The Electrical Properties of Pure Sulphur," by Prof. Threlfall, J. H. D. Brearley, and J. B. Allen.

Dyeing by Means of Electricity.—That indigo can be reduced by electrolysis was first practically demonstrated by F. Goppelsroeder, and this was hailed as a great achievement by the indigo dyers, who recognised at once the advantages of a "vat" that would not become silted up with sediment as is the case in the ordinary processes, thus causing an objectionable interruption to the working. Wartha has observed, however, that the prolonged electrolytic treatment of indigo causes a further change in the dyestuff, leading eventually to its total destruction; and for this reason he came to the conclusion that the practical use of the electrolytic vat is impossible. Recently J. Mullerus has pointed out that although the reduction of indigo cannot be satisfactorily effected in the cold, the operation can be most successfully accomplished at the boiling temperature. Goppelsroeder confirms this observation in a paper published in the *Chemiker Zeitung*, xvii., p. 1,633. He suggests the following treatment, which he has found in every way to work satisfactorily. The cloth to be dyed is impregnated with the indigo in a finely powdered condition; it is then immersed in a solution of caustic soda or lime, and passed in contact between two copper plates forming electrodes in a vat. When the current is sent through these plates the indigo in the cloth is reduced, and on subsequent exposure to the air the cloth becomes dyed a fine blue.

The New Engineering Laboratories at Cambridge.—The new Engineering Laboratories which were opened at Cambridge last week by Lord Kelvin, are built on a site bought by the University, which was formerly occupied by a grammar school. This has been almost entirely rebuilt, with the exception of a fine old hall of the seventeenth century. The rooms include a fine drawing office, electrical laboratories, elasticity laboratory, museum, lecture room, &c. The opening ceremony was performed by Lord Kelvin, with the co-operation of Prof. Kennedy and the Vice-Chancellor of the University. Among those present were Prof. Jebb, Sir George Stokes, Sir Frederick Bramwell, Sir Robert Ball, Prof. Ewing, Prof. Livey, and many Cambridge celebrities. Lord Kelvin referred to the great efforts made by Prof. Ewing, which had resulted in the erection and practical equipment of the laboratories so soon after his appointment, and expressed a hope that other donors would follow in the steps of those who had already so liberally contributed to the erection of the present buildings. He was followed by Prof. Kennedy and Sir Frederick Bramwell. There was an "at home" given by Prof. Ewing after the opening.

Personal.—Referring further to the "note" in our issue for April 20th, and the letter from Mr. Latham last week, regarding the appointment of Mr. R. H. Drummond at Madrid, we believe the real facts of the case are as follows: Mr. Chisholm is the chief *engineer* of the Electricity Supply Company for Spain, and Mr. Drummond ranks as chief *electrician* at the Madrid supply station, having his own staff of three assistant electricians.

How to Make Magnets.—Mr. Roy A. Crihfield, writing to the *Scientific American*, says: "It is frequently asked 'how to make and charge magnets.' It is somewhat a vexed question. The plan of touching the steel to be magnetised to the pole of a dynamo is beset with this difficulty: The field is so large, and the currents so strong, that if one pole of a U-magnet is laid on the pole of a dynamo, the influence of the polarity of the dynamo will extend beyond the contacting pole of the U-magnet, and partly destroy the polarity that should arise in the off or farthest pole of the U-magnet. I have devised and successfully used a plan that I give to the readers of the *Scientific American*. First, I take good tool steel, harden at the ends, and draw the temper to a bluish straw colour or edge tool hardness. Next take a piece of 1-inch iron gas pipe, about 8 inches long, then fill the hole from end to end with ¼-inch iron rods, filling the interstices with smaller iron wire. Dress both ends smooth. Now if there is a friendly street car or electric light dynamo in reach, apply *one end of the gas pipe* to either pole of the dynamo, and draw the U-magnet at right angles with the end of the pipe that sticks out. Apply the U-steel about half way from the bend to the point or pole. Draw the U then down to the point until it leaves the pipe, then draw the U away, and apply in the same manner again, using care not to approach the U any nearer to the dynamo than the outer end of the gas pipe. Then take the gas pipe to the other side of the dynamo, and treat *the other pole of the* U in the same way. I made a magnet in this way that held up 4⅝ths its weight, which is esteemed excellent magnetism." The *Scientific American*, in a footnote to the letter, says that the plan answers very well; but two rods of iron applied one to each pole, would probably prove more effective. It would be necessary to clamp the two bars rigidly, to prevent them from being drawn into contact with each other.

Electric Lighting of St. Paul's Cathedral.—A statement appeared in the *Daily Telegraph* last Monday to the effect that the recent experiments carried out regarding the electric lighting of St. Paul's were a failure. In response to this, Mr. C. G. Webber, of 27, Chancery Lane, E.C., has written to that paper as follows:—

I observe that you describe the experiment of lighting St. Paul's Cathedral on the 11th inst. as a "dismal failure," and "that the distribution of light was irregular and insufficient," also that "the intensity of the shadows is said to have been positively gruesome." As responsible, under the committee of the Cathedral authorities, I may be regarded as the "skilful electrician" who was consulted, and, therefore, trust you will permit me to correct the misapprehension under which your informant must have laboured. The experiment to which he refers was one of a series which have been made this year, the object of which has been to arrive at several conclusions on the question of cathedral lighting that have hitherto been obscure. Their objects have been to test:—

1. The comparative value of the arc and of the glow lamp as an illuminant in places used for public worship, especially with reference to the absorption of light by the stonework of St. Paul's.

2. The possibility of giving sufficient light, without standards or pendants, so that every individual in the congregation occupying so large a space as that under the dome of St. Paul's could read small print with ease; and also to ascertain the volume of light required to give that result.

3. The possibility at the same time of placing the light so that it would fulfil two conditions; namely, so that the glare of the incandescent portion of the lamps should not offend the eyes, either of the congregation looking eastward, or of the occupants of the choir and chancel looking towards the west.

It was proved conclusively by the experiments that these difficult but essential conditions could be attained without cross shadows, and that the illumination was most regular and adequate within the area dealt with, namely, the floor space under the dome. A few other tests were made in isolated portions of the cathedral from which the general results, on a more extended scale, could be estimated, and possibly your informant was unintentionally misled by the partial character of those results (quite understood by the committee) into adversely criticising arrangements which, if permanently reproduced on an extended scale, will place our metropolitan cathedral in front of all other ecclesiastical edifices as the great example of how electricity as an illuminant can be applied artistically, scientifically, as well as economically.

Electric Lighting of Paddington Infirmary.—The Paddington Guardians have decided to have the female's side of the Infirmary wards lighted electrically.

Royal Institution.—The Friday evening discourse at the Royal Institution on June 1st will be delivered by Prof. Oliver Lodge, F.R.S. The subject will be, as previously announced, "The Work of Hertz."

Congratulations.—We are glad to hear that the Queen has been pleased to confer a knighthood upon Mr. W. H. Bailey (of the well known firm of W. H. Bailey & Co.) in recognition of the services rendered to the country by him as a director of the Manchester Ship Canal.

Town Hall Lighting in Paris.—The Municipal Council of Paris has decided to light by electricity the Town Hall of the 20th Arrondissement. The administration has been charged to draw up a statement of the expenses, and to add the proposals of the Parisian Compressed Air Company. The arrangements for the lighting are to be completed before next winter, *i.e.*, by October.

The Minimum E.M.F. for Electrolysing Alkaline Salt Solutions.—Those who are interested in the commercial solution of the many problems connected with the electrolysis of chemical salts will welcome an important contribution to our knowledge of the subject, recently made by Mons. Nourrison at a meeting of the Paris Academy of Science. This physicist has now established and confirmed experimentally the following law:—The minimum E.M.F. necessary for the electrolysis of an alkaline dissolved salt is constant on the one hand for oxysalts, and on the other for haloids derived from the same acid. This result has also been verified by Mons. Max Le Blanc, who approached the subject from the standpoint of the theory of Arrhenius.

Electric Lighting of the Hospice d'Ivry, Paris.—The lighting by gas and oil lamps was pronounced unsatisfactory for the infirm wards at the Hospice d'Ivry, and it was therefore decided to have recourse to electric lighting. The authorities had to choose between two courses. One was to apply to the Edison Company in the neighbourhood for a supply of electrical energy. The other was to use a dynamo in the establishment and charge accumulators during the day. In the first case the first installation would cost 4,500 francs, and the annual outlay, including the subscription, the supply of electrical energy, the fixing of the meter and the laying of the mains, the maintenance of the lamps and conductors, would amount to 7,700 francs. In the second case, the installation of a dynamo, a battery of accumulators of 58 elements and 81 10-candle incandescence lamps, would cost 10,944 francs, but the yearly working expenses would only amount to 4,800 francs. The Municipal Council of Paris has chosen the second course, and the necessary preparations are now being made.

A Novel High Speed Engine.—A special development of the oscillating engine is reported from New Britain, Conn., the peculiar feature of which is that the cylinder is contained in the trunnion, the diameter of which is a little greater than the length of the cylinder. The cylinder is simply a hole bored right through the trunnion, and the steam pressure comes upon the cap of the trunnion bearing and does not press the trunnion piece itself upon its bearing. The piston rod passes through a long sleeve arm which extends half-way from the cylinder or trunnion piece to the crank pin; the trunnion is moved by this arm and not simply by the piston. The valve is cylindrical, and admits steam apparently to passages which communicate with channels upon the trunnion piece, and it is worked by an eccentric in the usual way, governed by weights in the fly-wheel. There are no packed joints, and the whole of the engine is of solid and substantial build, with no appearance of being other than successful as a high speed engine. It is said they have been run as many as 900 revolutions per minute. They can be reversed without links or external gearing. To us they seem particularly suitable for the direct driving of small dynamos or other similar purposes where a high speed is called for. The engine is manufactured on the interchangeable system by the J. T. Case Company, of New Britain, Connecticut.

Sir John Pender Gold Medal.—At the recent distribution of prizes to the students of the Glasgow and West of Scotland Technical College, this medal was presented to Mr. J. Fred Nielson as the best electrical engineering student who had completed the College diploma course in that subject.

The 50,000 Dollars Prize offered in America.—In a recent issue we referred to an offer made by the Metropolitan Traction Company, of New York, of a prize of $50,000 for the inventor of the most perfect system of street electric traction. After receiving between three and four thousand schemes, the company, on March 1st, withdrew their offer, stating that the State Railway Commissioners had declined to act as judges, as was originally intended. The *Electrical World* makes some very strong comments upon the action of the company, and considers that the time and money of several thousand inventors has been wasted over a sham competition. There is no doubt that any system which may eventually be adopted by the company will be most carefully scrutinised by the inventors whose schemes have been in the company's possession.

"Electricity from Melons."—A battery of 12 ripe melons in series is more than sufficient to ring an electric bell. No one would care to fly in the face of such a self-evident proposition, but an "inventor" has come forward who lays claim to be the discoverer of the ripe melon theory of generating electricity. Some three years ago he lived in Russia, and one day, when eating water melons, his face became suddenly rigid, and a piece of melon lay neglected in his mouth. With one accord his friends fell upon him and pounded away at his back, but with a strange noise he left the house. The working of his scientific mind led him to the fruiterer's, and later in the day his friends were still further alarmed to find him struggling with a dozen or so of ripe melons. However, the mystery was soon cleared up, for instead of graduating for an asylum, he was merely qualifying as an electrician. The melons were placed in a row, and had platinum wires stuck in the top and bottom, and from that time they rang the street door bell. The inventor calculates that, with a sufficient number of melons, the electricity resulting would light one's house. To those inclined to follow up the ripe melon theory, a few hints may be necessary. Melons, like transformers, are more efficient when they have been used for some time; in fact, you judge the efficiency by the "humming." Then again, to prevent nuisance, it would be useful to study the various forms of dust destructor, or if you want to be totally oblivious of the near neighbourhood of your generators, we should recommend a study of long distance transmission.

Wolverhampton Electric Lighting.—The Mayor of Wolverhampton (Alderman T. C. Mander), on Monday, laid the foundation stone of the Municipal electric light station in Commercial Road, the formal ceremony being followed by a luncheon at the Victoria Hotel, at which the Mayor presided. Following the toast of "The Queen," his Worship, in proposing "Success to the electric lighting works of the Wolverhampton Corporation," gave some particulars of the scheme. The question of electric lighting was first mentioned in the Council about five years ago, but action was delayed, and probably no one was any the worse for the matter having been proceeded with slowly, inasmuch as by waiting the Corporation had been able to introduce a system which was not available even four or five ago. The building in course of erection will afford facilities for increase of plant as demanded, but at present the intention is to put down machinery to supply 10,000 lamps. The current generated at 2,000 volts will be transmitted to a central sub-station at the Town Hall, from which it will pass to sub-stations at the Art Gallery and Free Library, where by means of motor transformers it will be reduced to 110 volts for general distribution. The architect of the building is Mr. A. P. Brevitt, the builders Messrs. H. Willcock & Co., and the electrical engineer Mr. F. Harman Lewis. The contractors for the electrical portion of the work are the Electric Construction Company, for the boilers Mr. John Thompson, and for the cables Messrs. Callender. The present contemplated outlay on land, buildings, and plant, is about £30,000.

Lectures.—A series of lectures on "Elemenantary Electricity and Magnetism" is being delivered at the Albert Institute, under the auspices of the Windsor and Eton Scientific Society, by Mr. E. E. Graves, of University College, London.

Before the Royal Scottish Society of Arts, a lecture was last week delivered in Edinburgh on "Electricity for Domestic Purposes," by Mr. Mathew Buchan.

Killarney Asylum and Electric Lighting.—In May, last year, the Board of Governors of this Asylum resolved to adopt electric lighting. Twelve months have elapsed, and apparently nothing has been done towards carrying out the work, for the new board have lately been considering whether to rescind the former resolution and continue the gas lighting. The cost of gas lighting is £350, whereas a Governor, who was present, said that the cost of electric lighting would be about £215 per annum. However, they do not credit this estimate, and the result of the vote was nine in favour of re-cinding the resolution and nine against. The meeting then adjourned to take advice as to the legality or otherwise of the chairman making a casting vote.

Electric Lighting at Rouen.—Some years ago a central station was established at Rouen, but during the last few months the authorities have invited companies to send in their tenders for the electric lighting of the quays. The Société Normande d'Electricité has succeeded in obtaining the work and also a fresh concession of 20 years. Certainly the conditions offered by this company are altogether exceptional, the selling price of the electrical energy will be ·09 fr. the hectowatt-hour for consumers, and ·045 fr. for municipal and public lighting. The company is to undertake at once a distribution extending over a radius of 1,000 metres; the municipal authorities are to receive a due of 20 per cent. of the gross receipts, public lighting excepted. The Société Normande has raised its capital to 1,400,000 francs. The works, which previously contained two Farcot of 500 H.P. each, are about to receive two more similar ones of the same power.

American Institute of Electrical Engineers.—Before the eleventh annual meeting of this Institution, held at Philadelphia, May 15th, and on the four following days, were read the following papers on electrical subjects:—Tuesday, May 15th, 1894:—1. "A Review of the Progress of the American Institute of Electrical Engineers;" an address by the President, Prof. Edwin J. Houston, of Philadelphia; 2. "On Light Distribution and the Use of Lamps," by Prof. Wm. A. Anthony, of Vineland, N.J.; 3. "Discriminating Lightning Arresters and Recent Progress in Means for Protection against Lightning," by Alexander Jay Wurtz, of Pittsburgh. Experimental demonstrations will be shown through the courtesy of the Philadelphia Traction Company. Wednesday, May 16th, 1894:—4. "Central Station Economy," by Mr. C. Reginald Van Trump, of Wilmington, Del.; 5. "Unipolar Dynamos for Electric Light and Power," by Prof. Francis B. Crocker and Mr. C. Howard Parmly, New York City; 6. "Relative Advantages of Toothed and Smooth Core Armatures," by Mr. Alton D. Adams, of Worcester, Mass.—Wednesday, May 16th, 1894:—7. "Test for Closed Coil Arc Dynamo," by Prof. R. B. Owens, of Lincoln, Neb.; 8. "Alternating Currents and Fuse Wires," by Prof. Dugald C. Jackson and Mr. R. J. Ochsner, of Madison, Wis.; 9. "Some Storage Battery Phenomena," by Mr. W. W. Griscom, of Haverford, Pa.—Thursday, May 17th, 1894:—10. "The Waste of Zinc in Open Circuit Batteries when Standing Idle," by Henry A. Lardner, of Madison, Wis.; 11. "Standardising Electrical Measuring Instruments: (*a*) by the Potentiometer Method; (*b*) an Improved Direct Reading Potentiometer," by Mr. Elmer G. Willyoung, of Philadelphia.—Friday, May 18th, 1894:—12. "Resonance Analysis of Alternating and Polyphase Currents," by Prof. M. I. Pupin, of New York City; 13. "Some Facts about Polyphase Motors," by Dr. Louis Bell, of Boston; 14. "The Law of Hysteresis (Part 3) and the Calculation of Ferric Inductances," by Mr. Charles Proteus Steinmetz, of Schenectady, N.Y.; 15. "Experiments with Two-Phase Motors," by Dr. Lewis Duncan, of Baltimore.

Muirhead v. Commercial Cable Company.—We understand that the Commercial Cable Company will appeal from the decision of Mr. Justice Kennedy.

The Cost of Electricity in Derby.—Some of the Derby Corporation customers declare that their electricity bills are less than previous gas bills.

The Société Internationale des Electriciens.—The last sitting of this Society took place on May 2nd, with M. Postel-Vinay as President. He first said a few words about M. Jablochkoff, and then thanked the Society for having elected him president. M. Sosnowsky gave a description of Laval's steam turbines working at an angular speed of 24,000 turns a minute, and M. Hillairet read a communication from M. Polier, who was indisposed, on the subject of motors with an armature closed upon itself. This paper was very interesting but very abstract, being full of formulæ that cannot be grasped on being read. The *Bulletin* of the Society will give a complete analysis of this paper.

The Propagation of Electricity along Lengthy Conductors.—In the current issue of the *Journal de Physique Théoretique et Appliquée* [iii.], III., pp. 107—110, there is a paper by Mons. A. Potier, in which he discusses the relative truthfulness of the two theories which are held with regard to the propagation of electrical energy along conductors of considerable length. He considers the case of a system of cylindrical conductors of indefinite length, and parallel to each other throughout their length, and supposes them to be the seat of very rapidly varying currents; for example, alternating currents of high frequency, or currents analogous to them, which would accompany the instantaneous charging of a portion of these conductors. It is known that such currents penetrate less profoundly the system of conductors in proportion as their variations are more rapid, and the specific resistance less high. Lord Kelvin, amongst others, has insisted on the identity of the law, according to which the current varies with the extent of penetration, with the law of the distribution of temperature in a metal of which the surface only is subjected to variations of temperature. Potier accordingly supposes the electrical currents to be entirely superficial—an extreme hypothesis, but necessary, in order to arrive at a net result. He then discusses the whole question from a strictly mathematical point of view, and arrives at the conclusion that the theories of Maxwell and Weber have common characters [this is in accordance with the recent experimental researches of Mons. Blondlot], and that one of these characters is unable to be considered as an *experimentum crucis*. The two theories, however, do not lead to identical solutions; but, for all that, Potier is led to the conclusion that, between them, there is very little to choose, and he asks those who may be working in this direction to specify for the interests of science, in describing their investigations, what results accord with which theory.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Willans & Robinson, Limited (25,665).—According to a document from the liquidator, filed at Somerset House on the 8th of last March, this company is in course of being dissolved. The document also states that consent has been given for the registration of a new company, to be called "Willans & Robinson, Limited."

Direct United States Cable Company, Limited (11,597).—This company's annual return has been lately filed, and shows that out of a nominal capital of £1,300,000, in £20 shares, 60,710 shares have been taken up, and agreed to be considered as paid.

Edison-Bell Phonograph Corporation, Limited (37,655).—This company's last return, filed at Somerset House on the 4th ult., shows that out of a nominal capital of £60,000, in £5 shares, the whole of the shares has been taken up. A sum of £40,000 has been received in response to calls, and £20,000 has been agreed to be considered as paid.

Ward Electrical Car Company, Limited (27,503).—This company's last return, filed on the 9th ult., shows that, out of a nominal capital of £300,000 in £10 shares, the whole number of the shares has been taken up, and that the full amount has been called upon seven shares. A sum of £70 has been received, and £299,930 has been agreed to be considered as paid.

Boy Messengers and Electric Call Company, Limited (33,954).—The registered office of this company is now at 58, Coleman Street, E.C.

Cambridge Electric Supply Company, Limited 36,457).—This company's annual return, dated March 21st, 1894, shows that out of a nominal capital of £50,000, in £10 shares, 2,775 shares have been taken up, and that £8 has been called on each. A sum of £22,200 has been received.

British Insulated Wire Company, Limited (32,594).—The annual return of this company was filed at Somerset House on the 4th inst., and shows that out of a nominal capital of £110,000, in 300 founders', 3,950 preference, 9,450 "A" ordinary, and 8,300 "B" ordinary shares, all of £5 each, the whole of the founders', 3,770 of the preference, 6,902 of the "A" ordinary, and 7,053 of the "B" ordinary shares have been taken up. The total sum received in response to calls is £46,270; £43,610 has been agreed to be considered as paid, and £5 has been forfeited on two shares.

Chamberlain & Hookham, Limited (18,175 C).—On the 1st inst. this company filed its yearly return, which shows that out of a nominal capital of £100,000, in 5,000 "A" and 5,000 "B" shares, all of £10 each, 1,000 "A" and the whole of the "B" shares have been taken up. There has been £3 10s. called on each of the former class of shares, and the 5,000 "B" shares have been issued as fully-paid. The total sum received in response to calls is £3,500.

Chatham, Rochester, and District Electric Lighting Company, Limited (24,773).—This company's yearly return, filed at Somerset House on the 9th inst., shows that out of a nominal capital of £50,000 in £5 shares, 3,890 shares have been taken up. The full amount has been called on 2,000 of these, and £2 on each of the remaining 27. The total received is £10,051 10s.; £9,315 has been agreed to be considered as paid, and £2 10s. is in arrear.

County of London and Brush Provincial Electric Lighting Company, Limited (34,320).—This company's annual return was filed on the 9th ult., and shows that out of a nominal capital of £800,000, in £5 shares, 200 shares only have been taken up, and that £4 has been called and duly paid. The total received is, therefore, £800.

Crossley Telephone Company, Limited (20,044).—The annual return of this company, filed on March 31st last, shows that out of a nominal capital of £100,000, in 5,000 "A," 12,500 "B," and 2,500 "C" shares, all of £5 each, 1,077 shares in all have been taken up. The full amount has been called, and £5,385 has therefore been received.

Benham & Froud Company, Limited (21,445).—This company's yearly return, filed on the 10th inst., shows that out of a nominal capital of £50,000, in £10 shares, 2,907 shares have been taken up, and that the full amount has been called on each of these. A sum of £28,947 10s. has been received, and £122 10s. is outstanding.

Anglo-American Telegraph Company, Limited (2,891 C).—The last return of this company, filed on the 14th inst., shows that the whole of the nominal capital of £7,000,000 has been fully paid up.

California Gas, Water, and Electric Light Company Syndicate, Limited (35,369).—The recent annual return of this company shows that out of a nominal capital of £2,000, in £1 shares, 1,475 shares have been taken up, and the full amount called and duly paid.

Direct Spanish Telegraph Company, Limited (6,732 C).—This company's yearly return, filed on the 13th ult., shows that out of a nominal capital of £95,000 in 13,000 ordinary and 6,000 preference shares all of £5 each, 12,931 preference and 6,000 ordinary shares have been taken up. The full amount has been called on each of the preference, and £4 on each of the ordinary shares. The total sum received is £81,724.

Woking Electric Supply Company, Limited (29,047).—The registered office of this company is now at Board School Road, Woking.

Yorkshire House-to-House Electricity Company, Limited (29,235).—This company's annual return, filed March 27th last, shows that out of a nominal capital of £100,000, in 19,900 ordinary and 100 founders' shares, all of £5 each, 10,000 ordinary and the whole of the founders' shares have been taken up. There has been £5 called on each of 7,366 ordinary shares, £2 on each of 2,634 ordinary, and the full amount on the 100 founders' shares has been agreed to be considered as paid. The total sum received is £41,900 10s., and there is £197 10s. outstanding.

Western and Brazilian Telegraph Company, Limited (7,251 C.).—The registered office of this company is now at Blomfield House, London Wall, E.C.

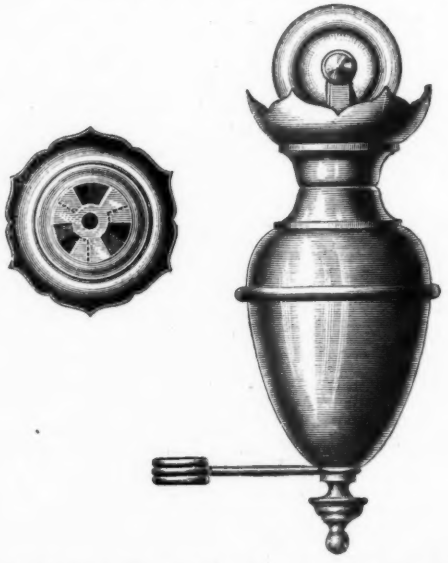
W. T. Henley's Telegraph Works Company, Limited (13,795).—This company's last return, filed on the 12th ult., shows that out of a nominal capital of £100,000, in 3,000 preference and 7,000 ordinary shares of £10 each, the whole of the preference and 6,837 ordinary shares have been taken up, and that the full amount has been called on each. The total sum received in response to calls is £98,370.

Western House-to-House Electricity Company, Limited (29,234).—This company's latest return was filed at Somerset House on the 9th inst. It shows that, out of a nominal capital of £100,000, in 19,900 ordinary and 100 founders' shares, all of £5 each, 107 shares have been taken up. The total sum received is £500.

Electrical Wonder Company, Limited (37,536).—According to the resolutions passed on November 27th last, the company is being wound up.

BUSINESS NOTICES, &c.

The "Ventilator" Counterweight.—We illustrate below a new counterweight for adjustable pendant lights which has been invented by Messrs. Chas. Joyner & Co., of Icknield Square, Birmingham. Rapid loading without loss of shot is effected by placing on top of the counterweight a funnel-shaped vase. By



giving a slight rotary movement to this vase the shot pours rapidly into the body of the counterweight. Another slight movement entirely closes the apertures. The vase largely conceals the pulley and imparts a finish to the fitting which is wanting in the ordinary type of weight.

Llandudno and Electric Lighting.—The committee which considered the draft of a provisional order for the electric lighting of the town, submitted by Messrs. Bellis & England, have recommended the board not to agree to the terms of the order, they being of opinion that the question should stand adjourned for a time, having a view to the fact that the constitution of the board would undergo a change in November.

London Chamber of Commerce.—The following is the report for the year 1893 of the electrical trades section of the London Chamber of Commerce:—During the year this section and its committees have held twelve meetings. The section has again had under its consideration the regulations of the Board of Trade on overhead wires. The Board have hitherto refused to modify these regulations, on the ground that they were drafted in consultation with the Institution of Electrical Engineers, and until alterations were recommended by that body they saw no reason to depart from the attitude already taken up. It is satisfactory to record that the Institution of Electrical Engineers has now recognised that, looking to the commercial aspects of the industry, it is absolutely necessary that these regulations should be to some extent modified, and negotiations were in progress at the end of the year which it was believed would remove the disabilities from which the industry now suffers in this respect, consistently, of course, with a due regard for the public safety. Another question considered by the section during the year was the position of the electrical industry in reference to the Telephone Company's monopoly of the use of earth. Recognising that this position was a serious hindrance to the development of the traction industry, the section resolved upon the appointment of an Electrical Traction Committee, which should have power to raise funds, engage counsel, and take such other steps as might be, in the opinion of the Committee, necessary for the advocacy or propagation of traction interests. This Committee was in due course constituted, and presented its case before the Joint Committee of the Houses of Lords and Commons on electrical power, with results entirely satisfactory to the traction industry. At the close of the year the Traction Committee were in communication with the Board of Trade as to the regulations under which the industry might be carried on consistently with the recommendations in the report of the Parliamentary Joint Committee already referred to. The section also directed its attention to the National Telephone Company's Powers Bill, railway rates on electrical goods, and the desirability of the promotion of lectures on the commercial aspects of the industry during the winter months.

Electricity in Mining.—Messrs. Ernest Scott & Mountain, Limited, have just completed for the Lothian Coal Company two large sets of electric pumping machinery, a third set to be added shortly. The same firm have in hand for Messrs. G. B. & T. E. Forster, for Cambois Colliery, Northumberland, seven sets of electric pumping machinery. Also for Messrs. Strakers & Love, a set of electric pumping machinery consisting of horizontal engine of 125 I.H.P., a 55-unit Tyne shunt-wound dynamo with overhead conducting cables, and a set of three-throw pumps. In the electric light department, the firm have in hand the lighting of the Edinbro Roperie with engine, dynamo to run 600 lights, and incandescent lamps throughout the Roperie. A large private house in Kirkby Lonsdale, in course of erection. This plant consists of a Priestman oil engine of 22 H.P., dynamo to run 200 lights with accumulators, and about 260 lamps throughout the house. They have just completed for the Coltness Iron Company an installation consisting of three dynamos, two machines being used for lighting the pit head and workmen's cottages, the third for an electric pumping plant, the pumps being placed by the river and capable of delivering 120 galls. per minute against a head of 160 feet.

Telegraph Wires.—It is a sign of the times, says the *Technical World*, when one of Her Majesty's inspectors asks a class of children in a public elementary school why telegraph wires appear to go up and down when looked at through the window of a fast train, and it is not surprising that the question should evoke some curious answers. Anything which develops observation and thought is to be encouraged, but the telegraph wires present greater difficulty to the youthful mind than most questions on common things, especially as the sag of the wires at a roadside is not generally very noticeable to the ordinary pedestrian. There must be some originality about the boy who suggested that the posts were fixed loosely in the earth, and went up and down with the passing train, and the boy must have had a lofty idea of the thoroughness with which the British workman carries out his duties.

Salisbury Proposed Electric Lighting.—Last week a special meeting of the Town Council was held for the purpose of considering a communication from Mr. William Henry Gramshaw relative to the proposed formation of a company to supply electric light within the city. The Town Clerk read the application, which asked the consent of the Council to a provisional order to be applied for to the Board of Trade before July 1st. It appeared that the promoters of the company had obtained the freedom of acquiring from the Dean and Chapter the Old Town Mill for the purpose of providing a motive power for the electric light. After some discussion, during which a general opinion was expressed in favour of the scheme, the meeting was adjourned for a week in order to test public feeling on the matter, and to obtain from Mr. Gramshaw fuller information with regard to the proposed undertaking.

Brighton Tenders.—The *Sussex Daily News* says there is a tremendous range in the tenders received by the Lighting Committee of the Town Council for the supply and erection at the electricity generating station of two motor alternators with the necessary switchboards and instruments, and for the supply of 12 transformers and 60 meters. Of seven tenders the highest is £5,147, and the lowest £1,731 17s. The latter is from the Electric Construction Company, Wolverhampton, and is recommended for acceptance. There are three tenders for supplying the alternating current cable required for Preston and north-east Brighton, together with the necessary joints and disconnecting boxes, the highest being £4,745 3s. 4d., and the lowest £3,579 6s. The British Insulated Wire Company quote the lowest price, and their tender is recommended for acceptance.

Bournemouth Electric Supply Company. — At a meeting of the Bournemouth Town Council last week, the Lighting Committee reported the receipt of a letter from the above company, notifying their intention to give a continuous supply of energy in certain streets, and of another letter from the same company enclosing statement of the company's accounts for the year ending December 31st, 1893. The Town Clerk reported that the Board of Trade had issued the electric lighting license, and the Council adopted the recommendation of the Committee, that the Surveyor be instructed to report on the power at his disposal for electric lighting purposes, and generally on the subject, with estimates.

Electricity v. Gas.—Mr. J. W. Manley, of Wardour Street, W., last year fitted up some premises in Bond Street for electric lighting. It is interesting to note there has been a saving of £2 in the cost of lighting those premises for the last quarter, as compared with the cost of gas for the corresponding quarter in 1893. The first quarter this year was noted for being remarkably light and free from fogs, and this circumstance is doubtless responsible for a certain amount of saving.

Ashton and Electric Lighting.—In view of the fact that the period limited by the electric lighting order of 1893, for the laying down of distributing mains in certain streets within the borough would shortly expire, it has been thought desirable by the Town Council that the question should be considered at once, and in connection therewith the practicability of providing a refuse destructor within the borough, and the utilisation of the steam power derived therefrom for the purpose of generating such electricity. A sub-committee was appointed to fully consider the questions.

Bazaar Lighting in Dublin.—For the lighting of "Araby," an oriental fête and bazaar held during Whitsun Week and part of this week, on the premises of the Royal Dublin Society, in aid of a local hospital, were brought into operation. Four steam engines and one gas engine, in all 150 H.P., for the lighting of the various buildings, entertainments, and grounds. In all there were about 1,000 incandescent lamps, 22 arc lamps, and two twenty-inch searchlights. The entire installation was carried out by Messrs. Edmundson, of Westminster and Dublin.

Swan's Electric Light Company, Limited.—At an extraordinary general meeting of the above company, held at 141, Pilgrim Street, Newcastle-on-Tyne, on April 21st, 1894, the following special resolutions were duly passed; and at a subsequent extraordinary general meeting, held at the same place on May 12th, 1894, the resolutions were duly confirmed:—1. "That the company be wound up voluntarily." 2. "That Thomas Rodham Hutchinson be appointed liquidator for the purpose of winding up the affairs of the company."

Factory Act Prosecution.—At Birkenhead on Tuesday the Hope-Jones Electric Organ Company, Limited, were summoned for failing to register their works as required by the factory act, and also with failing to exhibit in their workshop an abstract of the act. Mr. H. S. Richmond, inspector of factories, appeared to prosecute. Mr. Frank Hope Jones said their firm was not aware that they were required to do the things for which they were summoned. The bench imposed a fine of 10s. and costs on each information.

Huddersfield Electric Lighting.—A sub-committee of the Borough Council has been appointed to confer with the representatives of the Brush Electrical Engineering Company in regard to the failures in the transformer in use in the Town Hall. It has been decided to extend the electric main 450 yards in Westbourne Road. The tender of Messrs Calvert & Co., Folly Hall, for the supply of an air vessel has been accepted.

Taunton Electric Lighting.—The Watch, Lighting, and General Purposes Committee have made a report to the Town Council recommending that the municipal buildings be lit with electricity. The electrical engineer has estimated the cost of installing the light at £29 5s. 3d., the work to be done by the staff of the electrical works during the summer. This has been agreed to by the council.

Signalling in Trafalgar Square.—On Saturday evening last, between the hours of nine and eleven, a small company assembled at Messrs. Lombardi's photographic establishment in Pall Mall East, from the roof of which was given a display of sign-throwing by means of Mr. Ronald A. Scott's patent search lights.

Bedford Electric Lighting.—The authorities have resolved to adopt the scheme comprised in the report of Mr. F. H. Medhurst, who has been instructed to prepare detailed plans and specifications, and to insert advertisements in the usual newspapers inviting tenders for carrying out the work.

Electric Lighting of the University Galleries Extensions.—Messrs. Drake & Gorham have been entrusted with the electric lighting of the above by means of a considerable number of arc lamps of the Brockie-Pell type, and about 70 incandescents.

Winchester and Electric Lighting.—Some days ago Mr. Raworth (of the Brush Electrical Engineering Company) lectured before a public meeting at Winchester, on electric lighting. The members of the Corporation were present.

Mica—We understand that Messrs. Wiggins & Sons, of 102, Minories, E.C., have again obtained the Admiralty contract for the supply of mica. This is said to be the largest order for mica that has ever been placed by this department.

India-Rubber, Gutta-percha and Telegraph Works Company, Limited.—The Argentine Postmaster-General has applied to his Government for funds to pay this company for 30,000 insulators, bought at the rate of 90 cents each.

Electric Lighting at Grantham.—Several evenings last week the Angel Hotel was experimentally supplied with an installation of electric light by Messrs. Martin & Fitt, ironmongers, of High Street.

Mavor & Coulson.—Messrs. Mavor & Coulson, of Glasgow, have appointed the London Electrical Goods Agency, St. Margaret's Offices, 53, Victoria Street, S.W., to represent them in the London district.

Sale of the Carlow Company's Business.—The plant and goodwill of the Carlow Electric Light Company has been bought by a Major Alexander for £3,500. The original cost, we believe, was £20,000.

Electrical Exhibition at Dover.—An electrical exhibition is to be held in the Town Hall to-day and to-morrow. The hall has been fitted up with the electric light at a cost of £900.

Lighting of Portsea Guardians' Offices. — Messrs. Walker & Co., of Queen Street, Portsea, have secured the contract for lighting the offices of the Portsea Guardians.

The Electric Light at Tyldesley.—The "George and Dragon," Tyldesley, is being fitted with the electric light. Mr. Wm. Boydell, of Brown Street, Leigh, is executing the work.

CONTRACTS OPEN AND CLOSED.

OPEN.

Belfast.—May 28th.—For the erection of the central station in Chapel Lane, for the Electric Committee. Plan and specification can be seen and schedule of quantities, with form of tender, obtained on application to the Resident Electrical Engineer, Town Hall, Belfast.

CLOSED.

Baltic Canal.—It is stated that the contract for the establishment of the plant for the electric lighting of the North Sea Baltic Canal has been given by the German Imperial Canal Commission to the Helios Company, of Cologne. There were nine tenders sent in for the contract.

CITY NOTES.

Thomas Parker, Limited.

The issue of the week is undoubtedly that of Thomas Parker, Limited, which has been formed to carry on the business of manufacturers of plant for electric lighting, traction, and other purposes. The share capital of the company is £75,000, in £10 shares, of which 4,500 have been already taken up, the 3,000 left being offered to the public. It is scarcely necessary to say that the vendor and promoter of this company is Mr. Thomas Parker, the late works director and chief engineer of the Electric Construction Company. The prospectus states that the vendor has acquired the freehold of about seven acres of land on the Wednesfield Road, Wolverhampton, within a few yards of the Great Western, London and North Western, and Midland Railway Stations, upon which works are now in course of erection. In the *personnel* of its technical staff will lie the chief strength of the company, for, to all intents and purposes, it is composed of the well-known electrical men—Messrs. Woodward, Rees, Armstead and Iles—who recently seceded from the Construction Company. Mr. Parker has been closely identified with many of the important electrical developments in England for a number of years, and his personal superintendence alone ought to make the company successful. Further, we learn that Mr. Parker has entered into a contract with the company to act as managing director for a period of ten years, but we feel bound to ask whether Mr. Parker has undertaken to assign to the company all future patents taken out by him during this period. We fully expect that such an agreement has been made, but as there is no specific mention of such an arrangement, it is a fair question to ask. A valuable right has been secured to the company, for we learn that the vendor has acquired, and will assign to the company, the Eickemeyer patents for winding.

It is not surprising to learn that some of the statements in the report have been objected to by the Electric Construction Company, and as the differences between this company and Mr. Parker may possibly result in a legal process, we can say little about them at present. At the same time we must give publicity to the following letter from the Construction Company.

It is only fair, however, to point out, what the Construction Company admit, that Thomas Parker, Limited, are the owners for the United Kingdom of Eickemeyer patents for winding dynamos, but the Construction Company hold a licence under those patents. For obvious reasons we cannot at this stage pursue the matter further. We wish the company every success, and we see no reason why they should not attain to it.

Sir,—The attention of my board has been directed to the prospectus of Thomas Parker, Limited.

One of the chief inducements which is held out to subscribers is the acquisition of the Eickemeyer patents for winding dynamos; but the prospectus makes no mention of the fact that these patents are in Mr. Parker's hands subject to a general license in favour of my company for the whole of the United Kingdom.

The statement in the prospectus that "Mr. Parker and his staff designed and superintended" certain works is misleading, as only a portion of our staff employed upon the works in question has joined Mr. Parker since the board of my company dispensed with his services.

We have reason to believe that we shall have to claim certain of the other patents which it is represented on the prospectus will be transferred to the proposed company, as having been taken out by our employés.

The whole matter has been placed in the hands of our solicitors, Messrs. Linklater & Co.

James Gray,
Secretary.

The Electric Construction Company, Limited,
Queen Street Chambers,
Queen Street, E.C.

The Share Market.

We are pleased to note that the City and South London Railway Company's shares have been steadily rising during the past few weeks. The increase of traffic receipts has no doubt had a beneficial effect, and we fully expect to see this maintained. For some reason or other Elmore Companies shares show an upward tendency.

The West Coast of America Telegraph Company, Limited.

The directors' report for the year ended December 31st, 1893, to be presented at the 17th ordinary general meeting on 29th inst., states that the gross income for the year 1893 was £15,096 4s. 3d. as against £22,218 16s. 9d. in 1892, and in order to make up the loss on the year's working and to meet the debenture coupons, it was necessary to take £16,536 12s. 3d. from the reserve. The traffic handled in 1893 was larger than in the previous year, but owing to the the fall in the rates of Exchange both in Peru and Chili, which continued throughout the year, the sterling value of the receipts was considerably depreciated. The total expenses were £19,632 16s. 6d., against £21,919 14s. 8d. in 1892, a saving of £2,286 18s. 2d. The cable between Valparaiso and Talcahuano, 267 nautical miles, was successfully laid by the company's steamer *Retriever*, and opened for traffic on October 1st, 1893. A landline connects Talcahuano with the City of Concepcion. This addition to the system of the company was effected at a total cost of £29,699 4s. 3d. The traffic carried over this line, in the short time it has been open, is satisfactory. The landline between Buenos Ayres and Valparaiso, constructed by the Pacific and European Telegraph Company, Limited, was opened for traffic on March 19th, 1894. The completion of this line restored the direct service between the company's stations and Europe *viâ* Madeira. The directors regret to report the loss of an esteemed colleague through the death of Mr. Henry Roberts. The members of the board retiring, in accordance with the articles of association, are Mr. J. Denison Pender and Mr. Frederick Walters, both are eligible, and offer themselves for re-election. The auditor, Mr. John Francis Clarke, retires, and is eligible for re-election.

Stock Exchange Quotations.—Application has been made to the Stock Exchange Committee to allow the following to be quoted in the Official List:—Charing Cross and Strand Electricity Supply Corporation, Limited: Vendors' shares, Nos. 7 to 214, and 719 to 10,000.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending May 20th, 1894, amounted to £907; week ending May 21st, 1893, £794; increase, £113: total receipts for half-year, 1894, £18,212; corresponding period, 1893, £17,735; increase, £477.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. †	Dividends for the last three years. 1891.	1892.	1893.	Closing Quotation, May 16th.	Closing Quotation, May 23rd.	Business done during week ended May 23rd, 1894. Highest.	Lowest.
184,500£	African Direct Teleg., Ltd., 4 % Deb.	100	...	...	...	101 —104	101 —104	...	...
1,134,640£	Anglo-American Teleg., Ltd.	Stock	£2 12s.	£2 15s.	£2 11s.	43 — 45	42 — 44	43	...
2,932,680£	Do. do. 6 % Pref.	Stock	£5 5s	£5 10s.	£5 2s.	80½— 81½	80½— 81¼	81¼	80½
2,932,680£	Do. do. Defd.	Stock	...	...	...	7½— 8	7¼— 7⅜	7⅜	...
130,000	Brazilian Submarine Teleg., Ltd.	10	8 % §	6¼% §	6¼% §	12 — 12½	12 — 12½	12⅝	12 3/16
18,700£	Do. do. 5 % Bonds	100	...	...	...	100 —103	100 —103	...	...
75,000£	Do. do. 5 %, repayable June 1906	100	...	...	...	108 —112	108 —112	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 40,000	5	... §	10%‖ §	... §	1½— 2½	1½— 2½	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	140 —145	140 —145	...	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	3½% §	2 % §	... §	1/16 — 3/16	1/16 — 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	12 — 13	12 — 13	12⅞	12⅝
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	18 — 19	18 — 19	...	...
12,931	Direct Spanish Teleg., Ltd., £4 paid	5	4½%	4 %	4 %	2¾— 3¼	2¾— 3¼	...	...
6,000	Do. do. 10 % Pref.	5	10 %	10 %	...	8¾— 9¼	8¾— 9¼	...	...
60,710	Direct United States Cable, Ltd., 1877	20	3½% §	3½% §	...	9½— 10	9½— 10	9⅞	...
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6¼% §	6¼% §	...	14¾— 15	14¾— 15	15	14¾
70,000	Do. 6 % Pref.	10	6 % §	6 % §	...	15¾— 16¼	15¾— 16	16⅛	15⅝
105,900£	Do. 5 % Debs., repay. August, 1899	100	...	...	...	107 —110	107 —110	...	...
1,294,100£	Do. 4 % Mort. Deb.	Stock	...	...	...	112 —115 xd	112 —115 xd	114¼	113½
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7 %	15⅜— 15⅝	15⅜— 15⅝	15⅞	15 1/16
62,700£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	...	...	...	104 —107	104 —107	...	...
222,800£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	...	...	...	104 —107	104 —107	...	...
320,000£	Do. 4 % Deb. Stock	Stock	...	...	...	114 —117	114 —117	115¼	114½
95,100£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	...	...	...	103 —106	103 —106	...	...
129,100£	Do. do. do. to bearer, 2,344 to 5,500	...	...	...	...	103 —106	103 —106	104¼	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 2,016, red. 1909	100	...	...	...	104 —107	104 —107	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	...	...	...	105 —108¾xd	105 —108¾	106	...
180,227	Globe Telegraph and Trust, Ltd.	10	5¼% §	4¾% §	4⅝% §	8⅜— 9	8⅜— 9	9	8⅜
180,042	Do. do. 6 % Pref.	10	6 % §	6 % §	6 % §	15⅛— 15⅜	15⅛— 15⅜	15⅜	15 5/16
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅗% §	8⅗% §	8⅗% §	21 — 21½	21 — 21½	21⅝	21
200,000£	Do. do. do. 5 % Debs.	100	...	...	...	104 —107	104 —107	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	...	43 — 45	43 — 45	...	...
37,548	London Platino-Brazilian Teleg., Ltd.	10	...	...	...	4 — 6 xd	4 — 6 xd	...	...
100,000£	Do. do. 6 % Debs.	100	...	...	...	106 —109	106 —109	...	...
15,000	Monte Video Teleph. Co., Ord., 1 to 15,000	5	...	...	...	½— 1⅛	½— 1½	...	...
28,000	Do. do. 6 % Pref., 1 to 28,000	5	...	...	...	1 — 2	1 — 2	...	...
484,597	National Teleph., Ltd., 1 to 438,984	5	6 % §	5 % §	...	4⅞— 5⅛	4⅞— 5⅛	5	4⅞
15,000	Do. 6 % Cum. 1st Pref.	10	...	...	...	15 — 16	15 — 16	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	...	...	...	14½— 15½	14½— 15½	...	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 90,950	5	...	...	...	5½— 5⅝	5½— 5⅝	5⅝	...
925,017£	Do. 4½ % Deb. Stock Prov. Certs. ...	...	...	...	...	114 —116	114 —116	115¼	114½
48,800	New Teleph., Ltd., 25,901 to 74,700; £4 paid	10	...	...	...	... ...	... ...	...	...
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	...	...	3/16 — ¼	1/16 — 3/16	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	..	...	...	102 —105	102 —105	...	...
11,839	Reuter's Ltd.	8	5 %	5 %	...	5½— 6½	5½— 6½	...	...
3,381	Submarine Cables Trust	Cert	...	...	...	112 —116	112 —116	...	...
58,000	United River Plate Tel-ph., Ltd.	5	...	...	...	1½— 2	1½— 2	...	...
146,370£	Do. do. 5 % Debs.	Stock	...	...	...	90 —100	90 —100	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	4 %	..	...	3 — 5	3 — 5	...	...
249,900£	Do. do. do. 5 % Debs.	100	...	...	...	100 —103	100 —103	...	...
30,000	West Coast of America Teleg., Ltd.	10	...	...	...	2½— 3	2½— 3	...	...
150,00 £	Do. do. do. 8 % Debs., repay. 1902	100	...	...	...	105 —109	104 —106	107	105
64,242	Western and Brazilian Teleg., Ltd.	15	4 %	2½%	...	7½— 8	7½— 8	7⅞	7 7/16
33,129	Do. do. do. 5 % Cum. Pref. ...	7½	...	...	...	6½— 7	6½— 7	6⅝	...
33,129	Do. do. do. 5 % Def. ...	7½	3 %	...	...	2 — 2½	2 — 2½	...	...
178,200£	Do. do. do. 6 % Debs. "A." 1910 ...	100	...	...	...	106 —109	106 —109	107	...
222,700£	Do. 6 % Mort. Debs., series "B," red. Feb. 1910	100	...	...	...	106 —109	106 —109	108	107½
88,321	West India and Panama Teleg., Ltd.	10	¼%	¾%	...	1 — 1⅛xd	1⅛— 1⅜xd	1¼	...
34,563	Do. do. do. 6 % 1st Pref. ...	10	...	...	...	10¼— 10⅝xd	10¼— 10⅝xd	10⅝	10½
4,669	Do. do. do. 6 % 2nd Pref. ...	10	...	...	..	9 — 10 xd	9 — 10 xd	...	...
80,000£	Do. do. 5 % Debs. (1917) No. 1 to 1,000	100	...	...	...	109 —112	109 —112	...	...
$1,214,000	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	...	...	...	110 —115	110 —115	...	...
169,000£	Do. do, 6 % Ster. Bonds.	100	...	...	...	100 —104	100 —104	101¾	101½

ELECTRICITY SUPPLY COMPANIES.

20,510	Charing Cross and Strand Electy. Supply, 1 to 6, 215 to 718, and 10,001 to 30,000	5	...	5 %	4½%	4½— 5½	4½— 5½	...	..
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,000—180,000	10	...	...	...	12 — 13	12 — 13	12⅝	12⅛
20,000	Do. do. 6 % Cum. Pref., 1 to 20,000	10	...	6 %	6 %	13½— 14	13½— 14	13⅝	13⅜
100,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) £75 paid	...	...	...	...	83 — 85	83 — 85	84¾	84½
19,900	*Electy. Supply Co. of Spain, 101 to 20,000...	5	...	...	...	... ...	... ...	...	...
5,523	†Liverpool Electric Supply, £4 10s. paid	5	...	...	...	5⅛— 6⅛	5⅛— 6⅛	...	...
39,477	Do. do.	5	4½%	5 %	5 %	6⅜— 6½	6⅜— 6½	6½	6 7/16
49,900	*Metropolitan Electric Supply, Ltd., 6,101 to 50,000 ...	10	1 %	2 %	...	7½— 8	7½— 8	7¾	7 13/16
100,000£	Do. 5% Deb., 1 to 10,000 in bonds of £10, £20, £40	...	...	...	...	108 - 111	108 —111	109½	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	...	...	4⅛— 5⅛	4⅛— 5⅛	...	...
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-18,780	5	8½%	7¼%	4½%	6¾— 7⅛	6¾— 7⅛	7	6⅞
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8 — 8⅛	8 — 8⅛	8 7/16	...
59,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5		3½%	4 %	5⅜— 6⅛	6 — 6½	6 7/16	6⅛

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. ¶ Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1891.	1892.	1893.	Closing Quotation, May 16th.	Closing Quotation, May 23rd.	Business done during week ended May 23rd, 1894. Highest.	Lowest.
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000...	3	...	6 % §	6 % §	2⅜— 3	2⅜— 3	3	2⅜
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	...	6 % §	6 % §	2½— 2⅝	2½— 2⅝	2½	2½
125,000£	Do. do. 4½ % Deb.	Stock	...	...	...	108 —111	108 —111	108	...
630,000£	City and South London Railway	Stock	...	⅝%	⅝%	29 — 31	31 — 33	32½	30½
20,000	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 20,000	5	7 % §	7 % §	7 % §	3 — 3½	3 — 3½	...	...
50,000£	Do. do. 5 % 1st Mort. Debs., 1—400 of £100, and "A" 1—200 of £50 each	...	...	...	...	95 —100	95 —100	...	...
120,000	Electric Construction, Ltd., 1 to 120,000	2	...	...	...	¼— ⅜	¼— ⅜	...	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	...	...	...	1½— 1⅝	1½— 1⅝	...	...
100,000	Elmore's French Patent Cop. Deposg., Ltd., 1 to 66,750 ...	2	*nil*	*nil*	*nil*	1/16— 7/16	¼— ¼	...	..
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil* ¶	*nil*	*nil*	1¼— 1⅜	1⅜— 1⅝	1⅛/16	1¼
67,385	Elmore's Wire Mfg., Ltd., 1 to 67,385, issued at 1 pm. ...	2	*nil*	*nil*	*nil*	1¼— 1⅜	1 — 1¼	1⅜	1⅛
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §	*nil* §	*nil* §	½— 1½	½— 1½	...	...
9,600£	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	...	...	6½— 7½	6½— 7½	...	...
6,837	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	5 %	5 %	6½— 7½	6½— 7½	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	12½%	12½%	23 — 24	23 — 24	23⅜	23⅛
200,000	Do. do. do. 4½ % Deb., 1896	100	...	...	...	102 —104	103 —105	103½	...
37,500	†Liverpool Overhead Railway, Ord.	10	...	...	1 %	8⅜— 8⅝	8 7/16— 8 9/16	8⅝	8 9/16
6,295	† Do. do. Pref., £8 paid	10	...	...	...	12½— 12⅝	12⅝— 13½	12½	...
78,949	Swan United Electric Light, Ltd., £3½ paid	5	11 % §	10 % §	7½% §	2 — 2⅛	1⅜— 2¼	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	15 %	20 %	39 — 41	39 — 41	40½	40
150,000£	Do. do. do. 5 % Bonds, red. 1894	100	...	...	...	104—107	104 —107	...	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

CROMPTON & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%§; 1891—7%§; 1890—8%§.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5¼—5⅜.

Electric Construction Corporation, 6 % Debentures, 87—92.

Electric and General Investment, shares of £5 (£1 paid), 1⅞—2¼.

Electricity Supply Corporation, Ordinary of £5, 5—5¼.

House-to-House Company (£5 paid), 1—1½.

Do. do. 7 % Preference, of £5, 5¼—5½.

Do. do. 6 % Debentures of £100, 101—103.

Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 4⅜—5¼; 1st Preference Cumulative 6 %, £5 (fully paid), 6¼—6⅜.

Liverpool Electric Supply, £5 (fully paid), 6¼—6⅜.

Do. do. £3 10s. paid, 4½—4⅝.

London Electric Supply Corporation, £5 Ordinary, ⅞—1⅛.

Queen Anne's Mansions Lighting and Heating Company, 6 % £100 Debentures, 101—103.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares (£4 10s. paid), 4¼—4⅜.

Bank rate of discount, 2 per cent. (February 22nd, 1894).

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

DISCUSSION ON MR. CROMPTON'S PAPER ON "THE COST OF ELECTRICAL ENERGY," May 10th.

(*Continued from page* 585.)

Mr. SCHONHEYDER said he had intended to make some remarks about Mr. Crompton's statement as to the poor efficiency of Lancashire boilers, but there were other gentlemen in the room who would make them better than he could. He would only say that in making such a statement Mr. Crompton ought to have put a note stating the rate of evaporation in pounds of water; without that it was impossible to say whether the boiler was economical or not. The other point to which he wished to refer was in respect of water meters. It was evidently of great importance that the water should be measured for electric light stations, and Mr. Crompton had been good enough to refer to his (the speaker's) meter. He stated that it had given him very satisfactory results, and he agreed with what Mr. Crompton had said about it, both for and against it. He knew in many cases it had given exceedingly useful and accurate figures and shown what the evaporation per lb. of coal had been, and the difference in electric lighting stations under various conditions; but he was also aware that in many cases it had given trouble. It was not an easy matter to construct a machine which would work well when the only lubrication it got was water heated; the lime separated from the water formed a splendid grinding material, almost as good as emery, and for that reason the meter sometimes gave considerable trouble. But there had been instances where it had worked at 293°, and shown no sign of wear practically; but in that case the water was excessively soft. A part of the meter which had given no trouble whatever was the valve face. There they had a kind of eccentric movement which entirely prevented any cutting or galling. Wear there must be, but there was no cutting whatever, the face remaining perfectly good. He had lately arranged improvements whereby all the seven rollers and their pins were entirely on wheels, and he believed they had now got over all the difficulties in measuring hot water.

Mr. ROBERT HAMMOND said he was very sorry indeed to hear the opening speech—the rather ungenerous opening speech—of Major-General Webber, because only those who were accustomed to putting these statistics together knew the very grave difficulties which beset one who started out in the path Mr. Crompton had taken. He regarded this paper as one of the very best they had had in the Institution for a very long time, and it was a great pity that the opening speech should be one to decry the paper, its methods, and motives. It was impossible to believe that Mr. Crompton, in collating those figures, was aiming at proving some particular point upon which he had made up his mind at the start. He should rather, on the other hand, say that the paper was a monument of diligence, and one for which they ought to be very grateful to Mr. Crompton. He was very pleased indeed to get a copy of the paper a few days before the last meeting, and he took this opportunity of saying what he was sure all the members felt—that that was a most excellent plan. In fact, he should almost feel inclined to go a step further, and say that if everybody had a copy of the paper there would be no need to read it, so that they could start off at once with the discussion, as was so often done in other Institutions. With regard to the main point of Mr. Crompton's paper, they ought to be grateful to him for the prophecy of 3d. per unit, not as the cost of production, but the price at which they were going to deliver to consumers. It had been said it was a pity that he had mentioned such a figure, because those outside would be distressed to find that, whilst waiting for the 3d., they were being charged 5d., 5½d., 6d., and so on. He did not share those views. He thought the more they could make outsiders feel that this industry had a basis whereon it could compete directly with every other illuminant, and compete with it not only in quality, but in price, the sooner their fortunes as electrical engineers would be made. With regard to the 3d., however, it certainly was an alarmingly low figure, though it was agreed that it was only obtainable on a very large output; 3d. per unit, on 5,000,000 units, was £62,500 per annum; and, perhaps, Mr. Crompton, in his reply, would inform the members how many towns in England at the present time had gas companies with such a revenue. That 3d. per unit was equivalent to 1s. 6d. or 1s. 9d. per 1,000 feet for gas, and very few, in fact no companies in the Kingdom charged so low a price, except, perhaps, Plymouth, where the price was 1s. 10d.; therefore it was only fair to look out for those with incomes of £80,000 or £90,000 a year. He thought it would be found there were very few. Of course the question of output was the crux of the whole subject. In all these comparisons they too often forgot the question of output. It was impossible, with any justice, to compare the costs of two companies without taking the question of output into consideration first and last. He had been puzzling himself during the last two years as to how it would be possible to hit upon some method by which they could exclude the question of output, but he had failed to get a solution. He thought the plan of finding out what the extra cost of the extra output was from one twelve months to another did give them a bit of a guide towards the soundness of the working cost of any particular works. If it were possible, having attained a certain output, whatever it might be, to increase it by 10, 15 or 20 per cent. with only an increase in cost of 2½, 5 or 7½

per cent., then those works would be in an extremely sound condition, whereas if an increase in the load of 10 or 20 per cent. led to an increase of cost of 20 or 40 per cent., it would be very bad. Mr. Geipel referred to the average of some half-dozen or dozen of the companies in a certain list, and drew the attention of the members to the fact of the very great difference existing between the ideal figures of Mr. Crompton and the actual figures being obtained. There came in the question of output. The basis of Mr. Crompton's paper was that some huge concern, one of the big London companies, the Westminster, possibly, and the St. James's, the former of which was last year bordering on 2,000,000 units, should attain to 5,000,000, and then would manufacture at this ideal cost. But it was futile to compare the figures with those of companies whose output was so low as 40,000 or 50,000 units. The next point of Mr. Crompton's system was that he omitted depreciation. Mr. Crompton's reply, no doubt, would be that he had made ample provision for maintenance. That was a doctrine he would very much like to hold, but he dared not, for he could not shut his eyes to the fact that even if there were no depreciation there was an antiquation element to be considered. Some engineers, of course, would say that their plant would never become antiquated; but it was against the experience of engineering in the past and possibly—tell it not in Gath nor to any town councillor!—some of the alternators or some of the dynamos now in use in certain stations would not be in use in those stations 10 years hence. He said possibly; and if possibly, then it was necessary to consider, in estimating the cost, the question of depreciation. It was entirely omitted from Mr. Crompton's ideal figures. Mr. Geipel was surprised that Mr. Crompton said capital account had nothing to do with cost. Well, it had very little indeed to do with cost of production; but cost of erection had a good deal to do with the sinking fund and with the interest that was to be paid upon it. But as a manufacturing employment the question of its cost did not go very far into the calculation. Mr. Geipel said that possibly they might reach the ideal of £60 per kilowatt. It happened that at Leeds, where they began with only 250 kilowatts last year, and where the success had been so abnormal that they would finish this with 900 kilowatts, their cost, excluding land, would be below £60 per kilowatt. He thoroughly appreciated Mr. Crompton's hints, and the pioneer way in which he pointed out to station managers how they could decrease their costs; but he did think, and he was sure they would all agree with him, though Mr. Crompton had made little of it, that the great secret of cheaper cost in the future lay in getting something for their bye-products. They all knew that gas owed its cheapness to the very great value of its bye-products, and he thought they must agree that if electricity was going to be supplied at 3d. per unit, it must be by means of the bye-products, or what came to the same thing, by the bye-uses of the plant in those hours, 21 or 22 very often out of the 24, when the lighting was not called for. There was only one other point he wanted to make. It was just to stand up a little for some of the published data. Mr. Crompton said he preferred to rely upon the information he got from the central station managers; it was extraordinary to find, if they took up a balance-sheet, how very misleading it was. He would back the published data, if properly audited, against the kind of information received from the central station manager. For instance, he had picked up one or two balance-sheets which Mr. Crompton might have seen before. In the Birmingham one he looked among the central station costs, and found they were running the central station without any engineering charges at all. There it was—in the Board of Trade return! "Proportion of salaries of engineers, superintendents and officers, as certified by the managing director, nil." He happened to have had that balance-sheet to dissect and analyse, and he at once said he could not admit that. Upon searching he found the amounts under "Management, salaries of managing directors, &c." A certain proportion of that had to go back to the works costs, because he did not believe they were running the works without an engineer.

Mr. M'Laren joined with others in congratulations to the author for the very practical manner in which he had dealt with his subject. Those who knew Mr. Crompton would not expect anything else. He (the speaker) was not an electrical engineer, but a maker of engines for driving electrical machinery, and as such he might be allowed to make a few remarks on the paper. The question of the cheapness of the production of the electric light depended to a very large extent upon the motor by which that light was produced. The crux lay in the coal consumption, and in order to reduce the coal consumption it was necessary to have an engine which would use a small quantity of coal for the power that was given off. Now, in the published tests of engines, the information was very often incomplete, if not misleading. They very often read of the tests of particular boilers, and they were very interesting so far as they went, but they did not afford engineers sufficient information to enable them of themselves to choose which was the best boiler for the purpose of driving an electrical machine. A boiler might give a very good result in evaporation when tested by itself and by the water that was pumped into it, and by the steam that was given off from it; but if that steam was largely saturated with water, the evaporation which was ascertained by the test would be very misleading. On the other hand there were engine tests, which were conducted irrespective of the boiler which supplied the steam. Those tests might be very satisfactory, but if the engineer who was putting down an electrical installation was guided solely by the figures which were put before him in that way, he might be very far astray when he came to put his boiler and engine down. The only true criterion was to test the engines in connection with the boilers they were intended to work with, and having carefully noted the data, to see what the actual consumption was. The figures might look very pretty for the boiler, and very pretty for the engine, but when they came to be tried together they might be very far out. With regard to the question of steam generators, he agreed with the author of the paper in so far as the locomotive type of boiler was concerned, but he disagreed with him in regard to the amount of evaporation which he put down as the ordinary evaporation of a locomotive boiler. They had found in their own experience that the evaporation of locomotive boilers was a great deal nearer 10 than 7, at which it was put down in the paper. They had had in tests of their own locomotive boilers nearly 12 evaporated from and at 212°. He had no hesitation in undertaking that in the ordinary way, with a well-constructed boiler, they could depend upon an evaporation of from 10 to 11 lbs. of water per lb. of coal from and at 212°. The dry-back boiler was certainly a very good example of a very economical steam-producer, but, in his opinion, it was not so good as the locomotive type, although he believed it made a very good second. The evaporation of many boilers, especially of water-tube boilers, with all due respect to Mr. Robinson, was in many cases an unknown quantity, owing to the wetness of the steam which they frequently gave off. Then the Lancashire boiler was very much over-rated, because they found, as a rule, that the gases were generally discharged at 700°, necessitating the use of a very expensive economiser, for, unless the boiler was accompanied by an economiser, the efficiency as a steam-producer must be very low indeed. In the figures which had been published by Mr. Crompton, he gave results of steam engines of the working installation at Oxford. In that installation the utmost economy seemed to have been attained, for whilst the steam turbine headed the list with 310 B.T.U., at Knightsbridge they got 84, and at Oxford 88. Mr. Crompton's ideal was 36·25, so he thought at those two places they were within measurable distance of attaining it, taking the starting point of 300. He accounted for the great economy at Oxford by the fact of the engines being triple-expansion slow-running and surface-condensing. His firm opinion was, and he believed he would be supported by practical men present, that a great economy was to be obtained by the use of condensation, either by compound or by triple-expansion engines. The loss when working with a low load factor was very much less with that class of engine than with a non-condensing engine. Mr. M'Lean, from Oxford, was present, and he hoped they would have the opportunity of hearing what his experience was; he had no doubt it would bear out what he had said. He thought it was a very great mistake to put down high speed engines to drive electric plants. He did not expect that to go down readily, but he was quite sure, if he might be allowed to prophesy, that the future electric lighting engines would not be high speed small engines. They might just as well put an express locomotive on with small cylinders and small wheels to drive the express trains, and run it to death. With regard to the cost of maintenance, they knew something about single-action engines; he was not speaking of any particular engine, but of single-action engines generally. He knew some makers of engines of that class of engine would undertake to keep them in repair at rates very far beyond what would be required to keep slow-running engines in repair, and it was in the maintenance as well as in the economical production of steam, and the economical use of it, in his opinion, that the cost of electric lighting was going to be reduced.

Mr. M'Lean said Mr. Crompton had criticised the Oxford system on one or two points. He said that under the head of "Stores used in the generating works" the decrease had been very noticeable during the last few years of working, and in the case of Kensington Court it had reached as low a figure as 0·025d. per unit sold, adding that no doubt a lower figure would be reached as the output and load factor improved. Mr. Crompton was reported to have said, in speaking of the efficiency of distribution, that the Oxford figures came in at a late period, but that the results were very encouraging; in fact, were almost too good to be true, especially in regard to the use of stores as shown in Table VII. In that table Mr. Crompton gave 0·03 as his ideal; Kensington Court had reached that low figure. Why should he discredit the statement that they had reached the figures given at Oxford, which were still 50 per cent. above his ideal. It was no argument that because no other station had got so low they had not, and he was quite prepared to substantiate his statement. Mr. Crompton complained that he did not get the Oxford figures in time; he could only say that they were sent almost by return of post. When he said the statement was too good to be true he credited him (Mr. M'Lean) with a quality which he trusted he did not possess. It might interest Mr. Crompton to analyse their sheet of daily working, which he had with him; it was 4 feet 6 inches long. It had been checked with the figures in the office books, and the figures in this sheet did not show the company to be in as good a position as the book figures. Mr. Crompton said the transformer losses at Chelmsford had been cut down owing to the circumstances under which they were working, the circumstances being those of supplying the light between certain hours; a little further on he said they did not supply the light for 24 hours a day. The efficiency there went up to 76 per cent. However, it seemed a pity that they did not get the light at Chelmsford all the day round, seeing that they were paying for it. At Oxford they had a little bit of both—they could give a high tension or a low tension, so to speak; but they gave a continuous supply. With the output they had last year of only 100,000 units he thought they compared very favourably with some of the figures in *Lightning's* list. They were very small people down there, but they held the record in one or two items, and he was glad to have had the opportunity of coming there and substantiating his statements.

Mr. Burnett said he was only in a position to speak on the boiler question. Table V*a*. in Mr. Crompton's paper was a very nice idea, but it must not be forgotten that the boiler efficiency column included the engine-driver's efficiency and the fireman's efficiency. Table V. was also very useful; but it was only useful if the waste gases were of equal value. He thought Mr. Crompton was quite right where he said that in judging of the comparative value of fuels they should always remember that it was far more difficult to obtain a high boiler efficiency from steam coals than from those which contained a larger percentage of carbon in the form of coke. There

must be a grate to suit the quality of fuel used. Unfortunately, Table V*a*. was not of much use, because as yet the price of fuel was not in ratio with its thermal unit value, although he hoped the day would come when they would be able to buy it according to that value. In a paper read at Chicago, there was introduced a very rational practical test, and the author proposed to sell his coal by its thermal unit value. That was a paper worth reading. It seemed hard lines for electrical engineers to sell light and heat by pure B.T.U., and have to buy the raw material very much mixed. He sympathised with Mr. Crompton in what he said about the mechanical disadvantage of locomotive boilers, and he thought Mr. M'Laren slighty misunderstood Mr. Crompton in regard to that. He did not think he found fault with the efficiency of locomotive boilers, but with the difficulty of dealing with the low grates, in putting in the fuel and banking the fires, and certainly the ordinary locomotive fire-box type was not the best. Mr. Crompton mentioned the Economic boiler, and said it was a dry-back boiler. His firm were the makers of that boiler, and he would explain what they meant by a dry-back boiler. There was nothing new in it, or different from the Willans except that the piston chamber was affixed to the boiler, and from that it derived its name. In their part of the country they were using bituminous coal, and it was useful to remember that they had to make all boilers under Board of Trade rules, and the Board of Trade could not get in to inspect the boiler quite so well when the tube was right down on the furnace. It was pretty well acknowledged that the Babcock & Wilcox boilers could do, and had done, good work with Welsh coal, and he thought the grate radiation which Mr. Crompton feared would not be serious in a range of boilers, but only with a single boiler. He did not think, however, that it had been established that they were the best for efficiency. When used with bituminous fuel it was certainly not the best. He was greatly surprised that Mr. Crompton had so lightly passed over the more or less difficult problem of cleaning this boiler. It was a question as to how bad the boiler was made and how many thermal units were blown away. He also believed Mr. Crompton's information about flue boilers for very high pressures to depend on the intelligence of the firemen; if that did not increase with the increase of pressure they might have very serious trouble. The next step boiler engineers must take must be to analyse the merits of their boilers at different speeds and rates of evaporation, just as Mr Willans did with his engines. There was, in his opinion, no simple answer to the question, put so often, What is the best boiler? There was, he believed, no best all-round boiler, and the boiler engineer must be supplied with full particulars of what was required by the electric light engineers, the space available, output required, fuel, &c. Tables III. and IV. were very instructive, and went to show what scope there was for still greater intelligence and care on the part of firemen and engineers.

The discussion was here adjourned until May 24th.

REPORT OF THE ROYAL COMMISSION FOR THE CHICAGO EXHIBITION.

The report of the Royal Commission for the Chicago Exhibition (British Section) remarks as follows regarding the electricity section:—

XXV.—Electricity.

In this department, the building for which was 690 feet by 345 feet, Great Britain was very poorly represented Special efforts were made by the Electrical Committee, who were anxious to show at Chicago a typical English lighting station, and they also endeavoured to illustrate domestic electric lighting by showing a number of fitted rooms, as has been done in some exhibitions in this country. They, however, were not successful in either attempt. It had also been hoped that a share in the electric lighting of the exhibition might be allotted to some British firm, but the negotiations under this head came to nothing. It was by the division of the whole lighting scheme into sections, for which contracts were entered into with different nationalities, that the lighting at Paris was such a representative display. With one or two exceptions, notably in the case of Messrs. Siemens & Halske, who had the contract for lighting the terminal station, the whole of the electrical plant was American.

In the Electrical Building no steam was furnished or allowed, the idea being that electrical power alone was most appropriate. This secured a grand display for the electrical transmission of power, but was fatal to a large class of exhibits of great importance. Practice in both lighting and power is now almost entirely in direct coupled engines and dynamos, and such plant of this character as was exhibited could either not be run at all, or had to be run by making the dynamo a motor to turn the engine. This affected three exhibits.

The reluctance of English electrical firms to exhibit at Chicago was no doubt due, at all events in part, to the fact that most of them had taken part In the special electrical exhibitions which have recently been held at Frankfort and at the Crystal Palace.

The most important contribution in this department was the collection of historical telegraphic apparatus, lent by Her Majesty's Postal Telegraph Department, and exhibited at the expense of the Commission. The collection included apparatus dating from 1837, and also modern telegraph apparatus, as used at the present day in our telegraph department.

The financial statement shows the total expenses of the Commission as about £60,000, and there is still a very small balance in hand. A tabular statement showing the expenditure of the British Section at four previous International Exhibitions, as compared with that at Chicago is very striking. At the Paris Exhibition, 1889, Great Britain had 232,845 square feet, and the total expenses were £29,422, whereas at Chicago, where she had 500,074 square feet, notwithstanding the much greater distance from Britain, and the heavy cost of conveying exhibits, the total expenses were not £60,000. Salaries, &c., at Chicago were only £3,000 more than at Paris. Travelling expenses to Chicago were about £1,500 more than at Paris. Buildings, construction, office rent, &c., at Paris cost about £1,000 more than at Chicago, notwithstanding the much smaller space. Office and various expenses cost only about £700 more at Chicago than at Paris. Taking it all round, Paris was a more expensive exhibition, proportionally, than was Chicago.

The following appendices to the report are interesting:—

SUPPLY OF MOTIVE POWER.

By H. D. Wilkinson, Engineer to the British Section.

For operating the various machinery in the British Section, power was supplied by line shafting, by steam, by electric motors, and by compressed air. Three exhibitors of looms ran their machinery by electric motor, because by that means they could operate for as many hours as they wished daily, whereas the line shaft was only run from 8 a.m. to 5 p.m.

Except in the case of electric motors no charge was made for the supply of power when the machines using the same were not performing any work, but where anything was being driven by engines or manufactured by machines, a charge was made for the power estimated to be in use. It was impossible to measure the power absorbed by the various classes of machinery operated, but in every case I was able to negotiate a satisfactory understanding between the exhibitors and the chief of the building as to the amount of power actually used, and upon this the exhibitors agreed to pay.

Steam was charged at the rate of $40 for six months' supply per horse-power, or at 4 cents per horse-power hour. Compressed air was supplied at $60 per horse-power for six months, or at 5 cents per horse-power hour, and power from shafting was charged at the rate of $50 per horse-power for six months.

Exhibitors, who chose to drive by electric motors, had to purchase their motors from the manufacturing companies, as they could not be obtained on hire. The company having fixed a motor, there was then the cost of connecting it to the mains, for which the Exposition had a scale of charges ranging from $20 per horse-power for a motor of ½ horse-power or under, to $10 per horse-power for over 10 horse-power. The current supplied was direct at 500 volts, and the scale of charges for the six months ranged from $80 per horse-power for ¼ horse-power and less, to $60 per horse-power for over 2 horse-power.

Gas was also used for operating gas engines and other exhibits, and was supplied from the works of the Hyde Park Gas Company, situated outside the Exposition. The charge was made $1·50 per 1,000 cubic feet, with a discount of 30 per cent. if paid within six days from date of bill; no charge was made for meters, but a deposit was required. A charge of $3 was made for a permit to open ground and make connection to main, besides which there was the cost of laying branch pipe to exhibitor's space, and the connections from branch pipe to exhibitor's machinery.

In our Section I arranged for one pipe to be laid, sufficient to meet all demands, and divided the cost of the same between the exhibitors requiring gas supply.

Water was supplied from the Exposition pumping station and was charged for at the rate of 10 cents per 1,000 gallons. The water meters put in by the Department were charged to the exhibitors. The cost of fitting was as follows:—Permit for connecting to main $3·00; permit for connecting to waste $3·00; cost of meter $15·00 to $25·00; cost of branch pipe to exhibitor's space, and cost of plumbers' work to exhibitor's apparatus.

ENGINES IN THE BRITISH SECTION.

The horizontal compound engine lent by Messrs. Galloways (Knott Mill Iron Works, Manchester), was suitable for indicating 350 horse-power at 70 revolutions per minute, with 100 lbs. boiler pressure. It had low-pressure cylinder, 30-inch bore, placed over the high-pressure cylinder, 17-inch bore, both having a stroke of 3 feet 9 inches. The piston rods of these two cylinders drove on to one crank pin by means of connecting rods, the slide block for the low-pressure cylinder working on slide recessed in the bed-plate, and that for the high-pressure cylinder on steel slide bar forming a stay between the cylinder and the framing. The engine was fitted with Galloways' latest gear, the distribution of steam being effected by short slide valves. The high-pressure cylinder was provided with multi-ported or gridiron expansion valve working on the back of the main slide. The main slide was operated by eccentric from the crank shaft, and the expansion valve by curved slotted link, with an improved motion patented in 1890, allowing the admission of steam at full pressure without the intervention of a throttle valve, and giving a quick cut-off from any point from 0 to 66 per cent. of the stroke of the piston. The governor was driven by gearing, and was of the improved parabolic type, giving great sensibility and steadiness of turning; it was connected directly to the rod of the expansion slide valve, which it controls, giving admission of steam according to the load upon the engine. The crank necks are 12 inches in diameter, and the shaft carried a fly-wheel 23 feet in diameter, grooved for twelve 1¾-inch ropes. The condenser was placed in rear of the engine, the air pump being horizontal, worked direct by continuation of the low pressure piston rod.

The engines lent by Messrs. Willans & Robinson (Thames

Ditton, Surrey) were Willans's patent central valve engines, of 360 and 165 indicated horse-power respectively. They were *single acting*, all the brasses being kept constantly in compression, or "in constant thrust" (instead of being alternately *pulled* and *pushed*, as in ordinary engines), with the object of enabling them to run with smoothness and silence at extremely high speeds; the normal speeds of the two engines shown being, for instance, 350 and 380 revolutions per minute respectively. To scientific engineers the engine is well-known from the two series of trials carried out by its inventor, the late P. W. Willans, described in papers read by him before the Institute of Civil Engineers in London, in the discussion of which various American engineers took part. The economy figures given by those trials are still "record figures," the consumption falling as low as about 18½ lbs. per indicated horse-power per hour non-condensing, and to 12·6 and 12·8 lbs. condensing. The engines were in both cases triple expansion, with high steam pressure (170 lbs.), but they were very small, indicating less than 40 horse-power, and running at 400 revolutions per minute. The larger engine shown had three cranks, and of the standard "I.I.I." pattern; the smaller one, with two cranks, was of "H.H." size. The single-acting "constant thrust" engine is distinctively an English exhibit, as, although known in America, it was extensively used in England (in the form of an earlier type of the Willans engine), for several years before it was taken up there. English experience of it, in fact, extends over nearly 20 years. The one simple engine for combined dynamo and belt driving was of 60 indicated horse-power, at 470 revolutions per minute.

Another engine, of 300 indicated horse-power, was also shown, coupled direct to a Siemens Brothers' (English-made) two-pole dynamo, capable of giving 180 kilowatts, or 200 if required. The machine was designed to give 1,000 ampères and about 112 volts, at 350 revolutions per minute. The *combined* efficiency of engine and dynamo was about 85 to 86 per cent.—that is to say, that for each 100 horse-power *indicated*, 85 or 86 *electrical* horse-power is obtained at the terminals of the dynamo, and electrical losses in the latter amounting to 14 or 15 per cent. In plant such as that shown, with compound engines, the consumption of steam per electrical horse-power per hour is about 24 lbs. non-condensing; with triple-expansion condensing engines of the same pattern, it falls to barely 15 lbs. Though exhibited by Messrs. Willans & Robinson, Limited, the makers of the engines, this plant was lent by Messrs. Siemens Brothers, Limited, of Woolwich, England, to whom it belongs.

SUPPLY OF ELECTRICITY.

By H. D. Wilkinson, Director of the British Section.

It was by the division of the whole lighting scheme into sections, for which contracts were entered into with different nationalities, that the lighting at Paris in 1889 was such a representative display. With one or two exceptions, notably in the case of Messrs. Siemens and Halske, who had the contract for lighting the terminal station, the whole of the electrical power plant was American. Secondly, in the electrical building, no steam was furnished or allowed, the idea being that electrical power alone was appropriate to use. This secured a grand display for the electrical transmission of power, but was fatal to a large class of exhibits of great importance. Practice in both lighting and power is now almost entirely in direct coupled engines and dynamos, and such coupled plant here exhibited could either not be run at all, or had to be run by making the dynamo a motor to turn the engine This affected our section in three exhibits.

The general lighting of the various buildings was by arc lamps run in series on direct current circuits, but for all incandescent lamps and arc lamps required by exhibitors the supply was by high tension, alternating current with transformers.

The high tension wires at 2,500 volts were carried through subways to the principal points in the grounds, and from transformer pits located at points along the route, current at 100 volts was taken into the various buildings. The contract for the supply of this current was in the hands of the Westinghouse Electric Company.

The charge made by the Exposition Company for the use of lamps for six months was as follows:—Per incandescent lamp of 16 candle-power $8; per arc lamp of 2,000 candle-power $60.

To obtain this service the exhibitor had to pay the above in advance, together with the cost of making connection, wiring and fixing lamps, viz.:—Per incandescent lamp $3.50; per arc lamp $3.50.

The New York Insulated Wire Company had the exclusive right of putting in all wiring for exhibitors, and instances occurred in our own and foreign sections in which exhibitors had put in their own wiring, but could not obtain current for their lamps until they had paid the above wiring charges to the Exposition.

There was great delay in the fixing of exhibitors' lamps, as the first attention had to be given by the Electrical Department to the general lighting of the grounds and buildings, this being very much in arrear. Up to the expiry of the first three months, the full amount of $8 per lamp had to be paid in advance, and claims for rebate on the time of non-supply claimed formally afterwards, but requisitions for light after August were allowed on an advance payment of less than $8 per lamp, according to the time for which light was actually supplied.

THE PACIFIC CABLE QUESTION.

Sir Charles Tupper has sent the following reply to Sir John Pender in reply to the letter reproduced last week in these columns:—"Dear Sir John Pender,—In reply to your letter of the 15th inst., received yesterday after I had read it in *The Times*, I must first express my regret that you were prevented by indisposition from being present when my paper (of which I had sent you a copy) was read at a meeting of the Royal Colonial Institute on May 8th.

"You say:—'I cannot allow your statement to pass unchallenged that "the protest against the proposed cable is largely based upon fallacies."'

"Those who read that protest will find that it is largely based upon two statements, which I regard as fallacious. First, that 'the existing service was established solely by private enterprise—no Government subsidy, guarantee, or exclusive landing rights having been granted to the company.'

"I do not think any person reading that statement would suppose that the 'existing' companies with which the proposed Pacific cable will compete are now, and for many years past have been, assisted by Government subsidies and guarantees, amounting to the present time to £2,100,000. The Eastern Extension Company alone have received of that amount about £643,000, and the African lines, described by you as an alternative route to Australia, £1,337,000.

"Second, that the calculations made in the protest to show the unprofitable character of the undertaking assumed that the life of the cable would be only 14 years.

"You say:—'You are entirely mistaken in stating that some 5,350 miles (or about 30 per cent.) of the 18,000 of cable now forming the system of the Eastern Extension Telegraph Company is more than 20 years old and is still in working condition.'

"My authority for that statement was the Berne list, published in 1892, as furnished by the Eastern Extension Company to the International Telegraph Bureau, and which I accepted as reliable. The following are the figures:—

	Date of laying.	Length of cables in nautical miles.
From Madras to Penang	1870	1,455
" Penang to Singapore	1870	415
" Singapore to Saigon (Cochin China)	1871	637
" Saigon to Hong Kong	1871	983
" Singapore to Batavia (Java) ...	1870	539
" Banjowangie to Port Darwin ...	1871	1,137
" Flinders, near Melbourne, to Low Head (Tasmania)	1869	180
Total		5,345

"I will now add the highest existing authority on that question. Sir John Pender, at the meeting of the Brazilian Telegraph Company on the 2nd of this month, said:—'As you are aware, one of these cables is 20 years old, and therefore it is at all events approaching a period of age which causes us to be careful in providing for its renewal.'

"You say:—'Then again your description of the existing system as a "monopoly" cannot be justified.'

"I do not know what you call a monopoly, but I have under my hand the report made to the Government of Canada by Mr. Sandford Fleming (who was one of the Canadian delegates to the Colonial Conference, held in London in 1887). In that report, speaking of the discussion upon this cable question, he says:—

"'The Postmaster-General (Mr. Raikes) stated very forcibly that it would be absolutely impossible for the English people or for Her Majesty's Government to recognise the monopoly which the company seemed to claim.'

"With the evidence before me that active efforts are now in operation to promote the construction of a Pacific cable under the control of a foreign government, I cannot share your doubt as to its probability, nor can I agree with you as to the strategic value of a British Pacific cable, concurring, as I do, with the opinion expressed by the *Globe* of the 19th ult., which in an article very friendly to the existing lines, says:—

"'In the first place, there can be no question at all that a cable across the Pacific would be of the very highest strategical importance to us. Not only would it furnish us with a duplicate medium of communication with our furthest colonial possessions, but it would also have the advantage of standing less chance of being cut by our enemy in time of war. The eastward bound cables, by means of which we communicate with Australia at present, touch far too many places *en route* to be strategically safe. Moreover, if an enemy should succeed in cutting the cable, it would probably be somewhere between Aden and England, in which case India would be completely cut off from telegraphic communication. The proposed Pacific cable, however, would then enable us to transmit our messages by an alternative western route.'

"I do not propose to discuss the question of traffic or the normal increase that may reasonably be expected, further than to say that I have reason to believe that no difficulty will be experienced in securing the construction and operation of the cable upon the lines suggested by the Wellington conference, or such a modification as may be adopted by the conference shortly to be held at Ottawa.

"Having confined my remarks to the principal points raised in your letter,

"I remain yours faithfully,

"Charles Tupper.

"P.S.—I have sent a copy of this letter to the *Times*."

NEW PATENTS—1894.

8,982. "Improvements in dynamo-electric machines." T. B. Grant. Dated May 7th.

9,117. "Improvements in and relating to electro-magnetic tools." P. Jensen. (Communicated by G. Fonda). Dated May 8th. (*Complete.*)

9,123. "Improvements in and relating to electric railways." H. S. Maxim. Dated May 8th.

9,129. "Improvements in electrolysis." H. Blumenberg, jun. Dated May 8th.

9,178. "An electrolytic meter for measuring electric currents." A. G. Waterhouse. Dated May 9th.

9,184. "Improvements in conductors for the distribution of electrical energy and the insulation thereof." G. Wilkinson. Dated May 9th.

9,215. "Improvements in the system of circuit control for electric machines." C. E. Davis. Dated May 9th. (*Complete.*)

9,285. "Improvements in or relating to electrodes, and method of manufacturing the same." C. Kellner. Dated May 10th.

9,292. "Improvements in or connected with electrolytic cells." E. A. Allen. Dated May 10th.

9,295. "Improvements in electric lamps for bicycles and similar vehicles." H. H. Lake. (Communicated by G. Mayr, United States.) Dated May 10th.

9,328. "An improvement in and relating to apparatus for electrolysis." B. Hooker. Dated May 11th.

9,342. "Improvements in the methods of electrically coating wire tubes and similar articles." R. Heathfield, and W. S. Rawson. Dated May 11th.

9,348. "Improvements relating to electric lighting." A. Wilson. Dated May 11th.

9,350. "Improvements in apparatus for electric lighting by means of primary or secondary batteries." A. Ford-Lloyd. Dated May 11th.

9,351. "Improvements in apparatus for testing telephone lines." C. H. Elliot. Dated May 11th.

9,357. "Improvements in and relating to electric arc lamps and their construction." W. Rowbotham and E. Rowbotham. Dated May 11th.

9,362. "Electric alarm clocks with advertising spaces." S. S. Bromhead. (Communicated by F. Beuner, United States.) Dated May 11th. (*Complete.*)

9,364. "An improved lubricant, chiefly designed for use on the collectors of dynamo-electric machines." D. Young. (Communicated by J. Marius, Italy.) Dated May 11th.

9,368. "Improvements in electric fuses." F. Brain. Dated May 11th.

9,399. "A combination of the electric overhead trolley system and the electric accumulator system for railways and tramways." A. Dickinson. Dated May 12th.

9,403. "Improvements in pumps for oil engines or other purposes." W. H. Scott. Dated May 12th.

9,410. "Improved means of gripping cords, wires, or the like, for electrical or other purposes." C. H. Cutting, G. H. Cutting, and I. Cutting. Dated May 12th.

9,437. "Improvements in the method of and apparatus for regulating the amount of light from electric glow lamps." H. Lea. Dated May 12th.

9,456. "Improved junction or fuse box for electric wires." C. N. Russell. Dated May 12th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1893.

4,580. "An improvement in telegraphic apparatus for railways." E. Tyer. Dated March 2nd. Claims:—1. In telegraphic apparatus for railways of the kind described in the Specification No. 2,575 of 1879, a sending instrument consisting of a plunger, spring lever, a pair of crown ratchet wheels, a cam toothed wheel and contact lever, arranged and operating in combination with a perforated dial and pin, substantially as described. 2. In combination with a sending instrument such as is above referred to a receiving instrument, consisting of an electro-magnet spring armature and plunger lever, a pair of crown ratchet wheels, and an index arranged and operating substantially as described.

5,684. "Improvements in portable electric primary batteries, and in their application to miners' and like portable lamps." M. P. Tuckerman and A. D. Mackenzie. Dated March 16th. Relates to the construction of portable batteries, so that the liquid shall not escape or affect the connections when the battery is carried about or otherwise disturbed. 3 claims.

5,844. "Improvements in storage batteries." W. P. Thompson. (Communicated by M. Hartung, of Berlin.) Dated March 18th. Consists in a novel construction of a plate or grate for holding the active material of the storage battery plates. The said grate differs from those hitherto employed for the same purpose in being composed of bars which cross or intersect each other, and are of the same height, and arranged in the same plane. The said bars have a triangular or semi-circular, or similar cross section, and the one set of bars of the grate, which are arranged in one direction parallel or concentric to each other, have the base of their triangular or semi-circular cross section turned to one surface of the grating, while the other set of bars, which cut or intersect those of the first set, have their base turned to the reverse surface of the grating. 1 claim.

6,032. "Improvements in switches for electric light fixtures." B. J. B. Mills. (A communication from J. Hutchinson, of New York.) Dated March 21st. The main object is to provide a simple and practical way of applying switches to ordinary tubular arms, and the invention consists in the combination with such a tubular arm of a switch secured directly to the outside thereof. 1 claim.

6,050. "Improvements in alternate current motors." O. T. Blathy and M. Deri. Dated March 21st. The connecting points of two contiguous spools or sections of the winding of an armature wound in the ordinary manner of dynamos, whether of drum, ring, or disc form, are not directly connected to one of the plates of the collector, but there is introduced between the said point of connection and the collector plate an intermediate piece which either possesses a suitable (Ohmic) resistance, or a suitable self-induction, or both combined. The action of this intermediate piece consists in that it prevents the increase of induced current in the spool closed by the brush, beyond a certain degree, thus reducing to a minimum the above-named detrimental effects. 5 claims.

6,439. "Improvements in electric switches." T. E. Marsh and T. G. Poole. Dated March 27th. Consists of an arrangement by which the switch arm or bar is automatically locked, and the throw-off springs can only be released by the movement of the handle, with the additional advantage that, supposing the said springs fail to act from any cause, the movement of the handle effects a positive action on the contact bar and releases it. 1 claim.

6,613. "Improvements in street and like boxes for containing transformers used in electrical distribution." C. A. Parsons and J. B. Willis. Dated March 29th. Consists in arrangements of boxes whereby the said boxes can be formed of one metal casting, or of several castings bolted together so as to be watertight. 6 claims.

6,642. "Improvements in securing the socket shank of electric incandescent lamps." D. Mather and J. Kemp-Welch. Dated March 29th. The inventors form the stem end of the lamp with a groove or other suitable means to prevent the cement slipping off, and form the top of the brass band with an inner edge, rim or indentations to secure it to the cement. 1 claim.

6,666. "Improvements in or relating to the distribution of electricity." W. Geipel. Dated March 29th. Claim:—In distributing electricity by transformers when using two or more distinct primary mains or networks or circuits to feed the same low tension secondary circuit, the combination with the transformers of an improved method of switching them off from the secondary mains by opening the circuit of the particular primary mains, to which are connected the transformers required to be switched off, substantially as described and shown.

13,448. "Improvements connected with or relating to meters or instruments for measuring electricity." F. H. Aschner. Dated July 11th. Claim:—A measuring instrument (or meter) for directly reading off the cost of the actual consumption of electrical energy, having a scale the divisions of which, at the tension taken as the basis in the group of wires or conductors, give the cost calculated on the actual consumption of current per hour, substantially as described.

20,046. "Electric selecting devices." S. S. Bogart and The Electric Selector and Signal Co. Dated October 24th. Relates to that class of instruments wherein a transmitting device sends out a combination, or a pre-determined arrangement, of electrical impulses to any selected one of a series of selecting instruments, each of which is constructed and adapted to respond to its own combination or pre-determined arrangement, and to no other, by means of certain movable mechanical representations of the electrical impulses controlled or worked out by the armature lever of an electro-magnet operated by the transmitted impulses to impel the movable mechanical representations of the impulses to the end of its course or phase, operate a signal or other device, return an answer-back message, and restore the selecting instrument to its starting point. 13 claims.

20,799. "Improvements in electric incandescent lamps." M. H. Habtogh. Dated November 2nd. Refers to electric incandescent lamps, in which two or more carbon filaments are employed, and the improvements in such incandescent lamps relate to the connection of the carbon filaments with each other as well as with special contact pieces, arranged in the socket of the lamp, the whole for the purpose of allowing the insertion of another carbon into the electric circuit as soon as the filament used before is burnt or broken. 5 claims.

21,592. "Improvements in electric switches for operating electrical indicators or signals." H. Reid. Dated November 13th. Claims:—1. Improved means of operating electrical indicators and signals by the use and application of a sliding bolt or lever in combination with a tumbler, pendulum or crosshead, fitted with two insulated metallic plates, substantially as described and shown in the drawings. 2. The several combinations and arrangements of parts for obtaining electrical contacts, disconnections and reversing currents for operating electrical indicators and signals, substantially as described and shown in the drawings.

24,607. "Improvements in contact making apparatus for electric switches and the like." E. A. Claremont. Dated December 21st. This invention relates to levers such as are employed in electrical switches, but is alike applicable for levers that are used in connection with other electrical appliances. 1 claim.